



# Living Switzerland

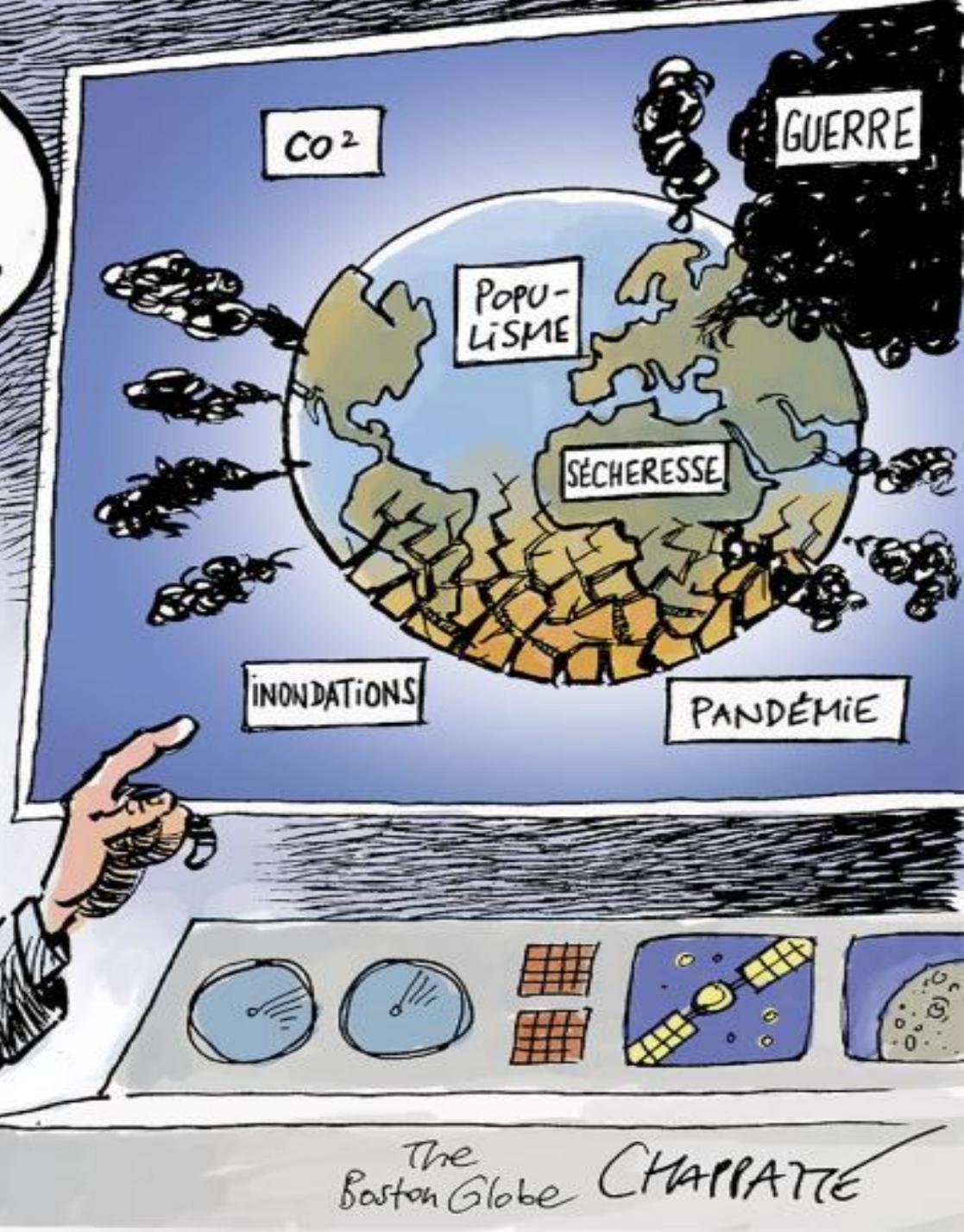
## Un jumeau numérique de l'environnement suisse

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[Université de Genève]

L'ASTÉ-  
ROÏDE,  
C'ÉTAIT  
FACILE

MAINTENANT  
COMMENT  
ON CHANGE LA  
TRAJECTOIRE DE  
CETTE PLANÈTE ?



The  
Boston Globe CHAPPATE



BE SURE TO WASH YOUR HANDS AND ALL WILL BE WELL.

COVID-19

RECESSION

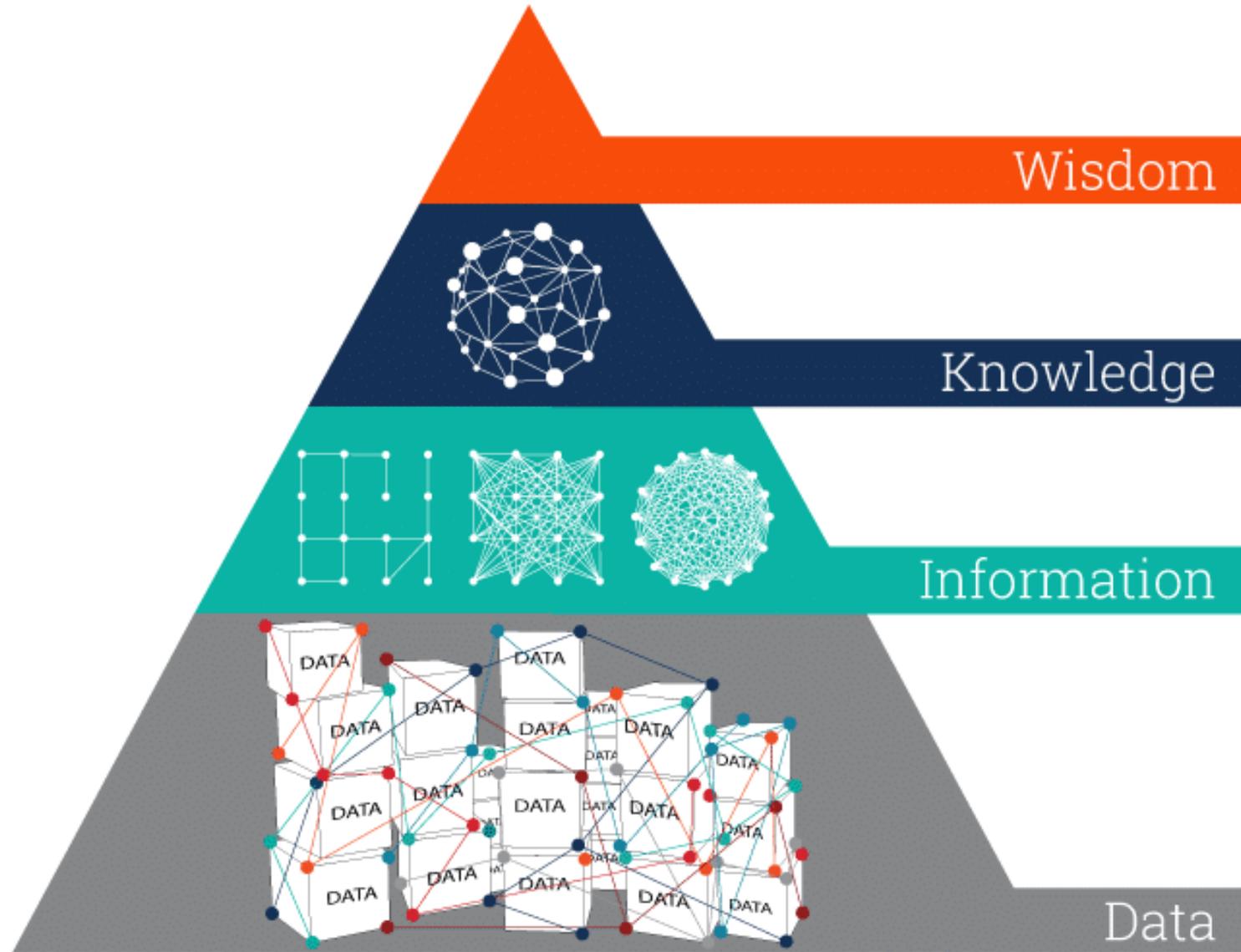
CLIMATE CHANGE

BIODIVERSITY COLLAPSE

POLLUTION

MACKAY

# Des recommandations actionnables fondées sur des évidences!



**Chaque étage** de la pyramide répond à des questions et ajoute de la valeur aux données initiales

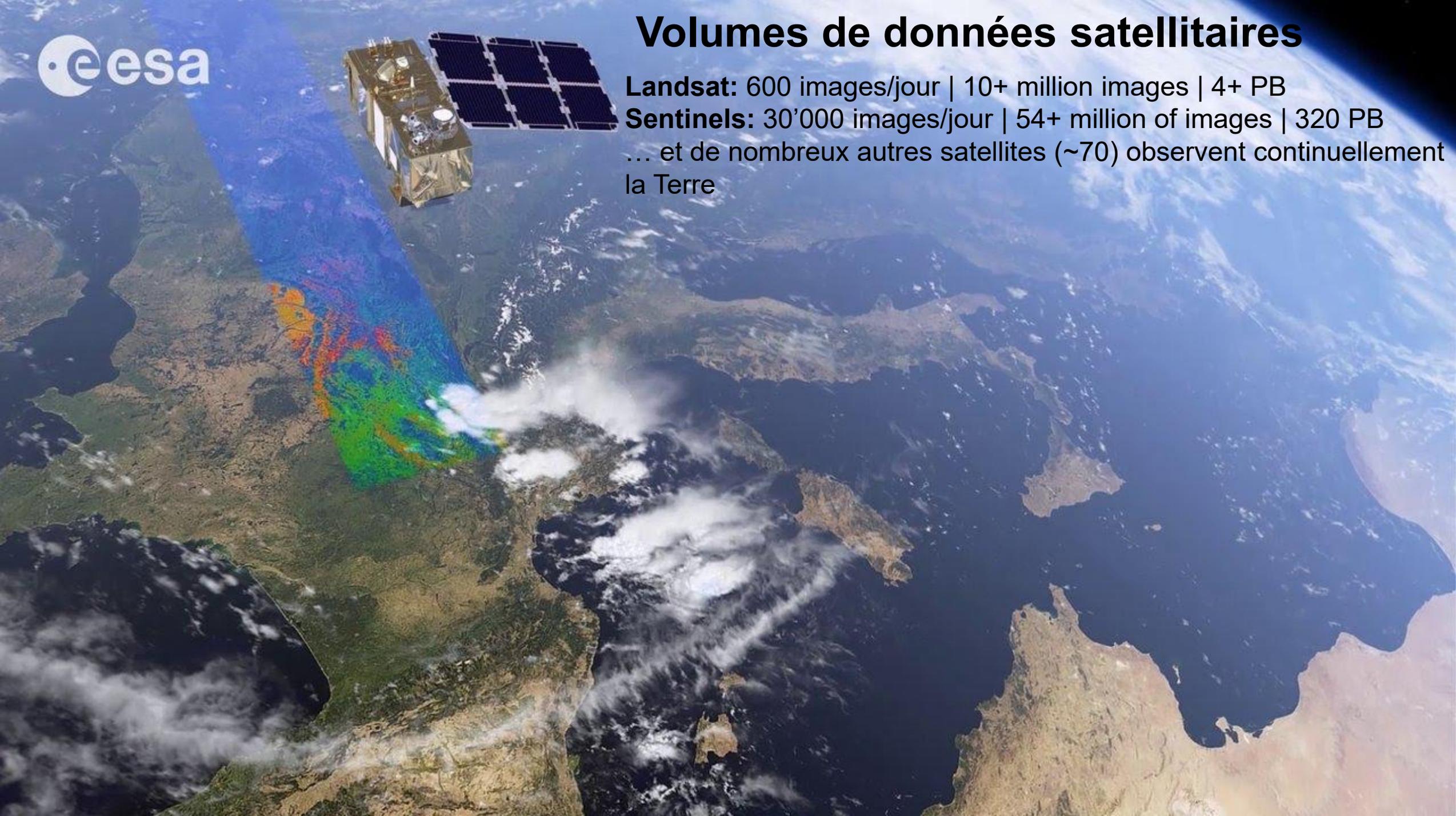


# Volumes de données satellitaires

**Landsat:** 600 images/jour | 10+ million images | 4+ PB

**Sentinels:** 30'000 images/jour | 54+ million of images | 320 PB

... et de nombreux autres satellites (~70) observent continuellement la Terre



A photograph of Al Gore speaking on a stage. He is wearing a dark suit and a light blue shirt. Behind him is a large, illuminated globe of the Earth. The text is overlaid on a semi-transparent grey band across the middle of the image.

*“Le satellite Landsat est capable de prendre une photographie complète de l’ensemble de la planète toutes les deux semaines, et il collecte des données depuis plus de vingt ans. Malgré le besoin énorme de ces informations, **la grande majorité de ces images n’a jamais déclenché le moindre neurone dans un cerveau humain.** Elles sont simplement stockées dans des **silos électroniques de données.**”*



**Comment transformer ce large volume de données en information utile pour supporter la prise de décisions basées sur des évidences?**



# SWISS DATA CUBE *en chiffres*

Une archive unique de données prête à l'analyse

**MaJ hebdomadaire!**

**40+ years**

FROM 1984 to 2025

**10 sensors**

LANDSAT 5/7/8/9;  
SENTINEL-1AB/2AB/3/5P

**Official gov. data**

DEM; Climate models; Land Cover,...

**EO data products**

NDVI, NDWI, EVI, LAI, ... time-series

**> 450 million**

PIXELS

**> 3000 billion**

OBSERVATIONS

**10-30-90m**

PIXEL RESOLUTION

**~ 80'000 images**

INGESTED

**~30 TB**

ANALYSIS READY DATA

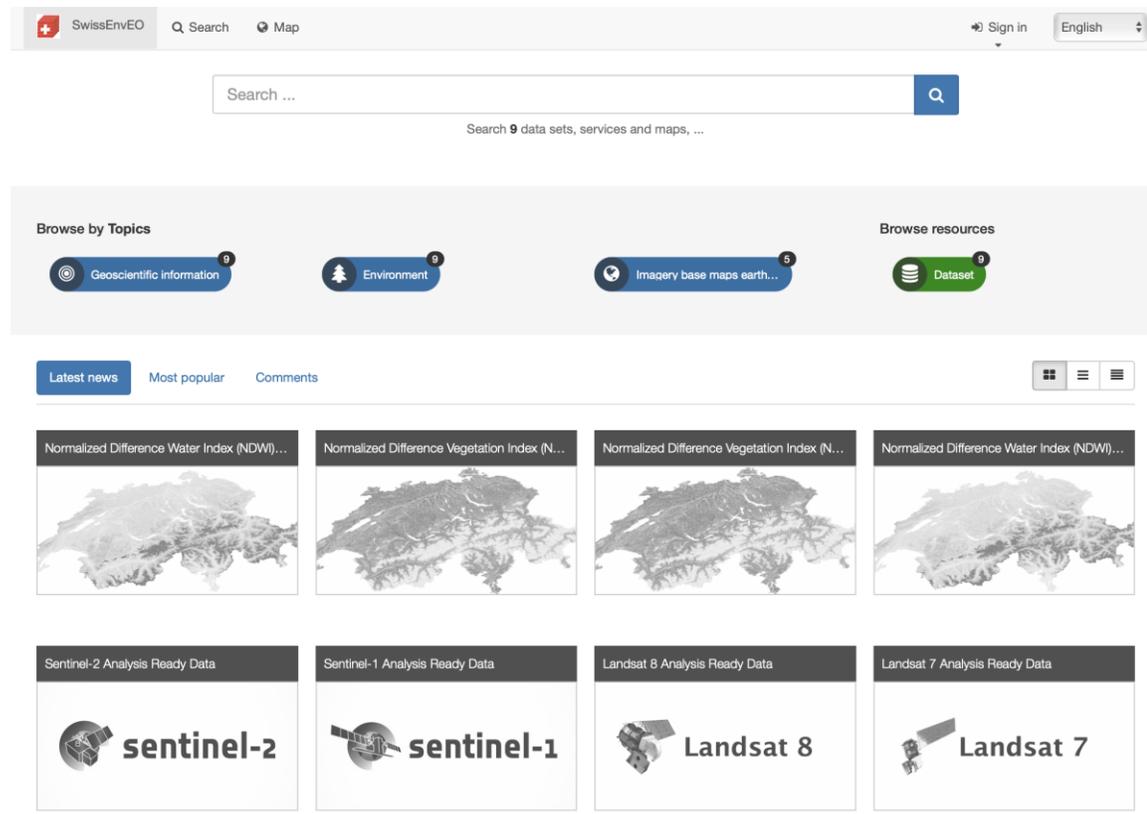
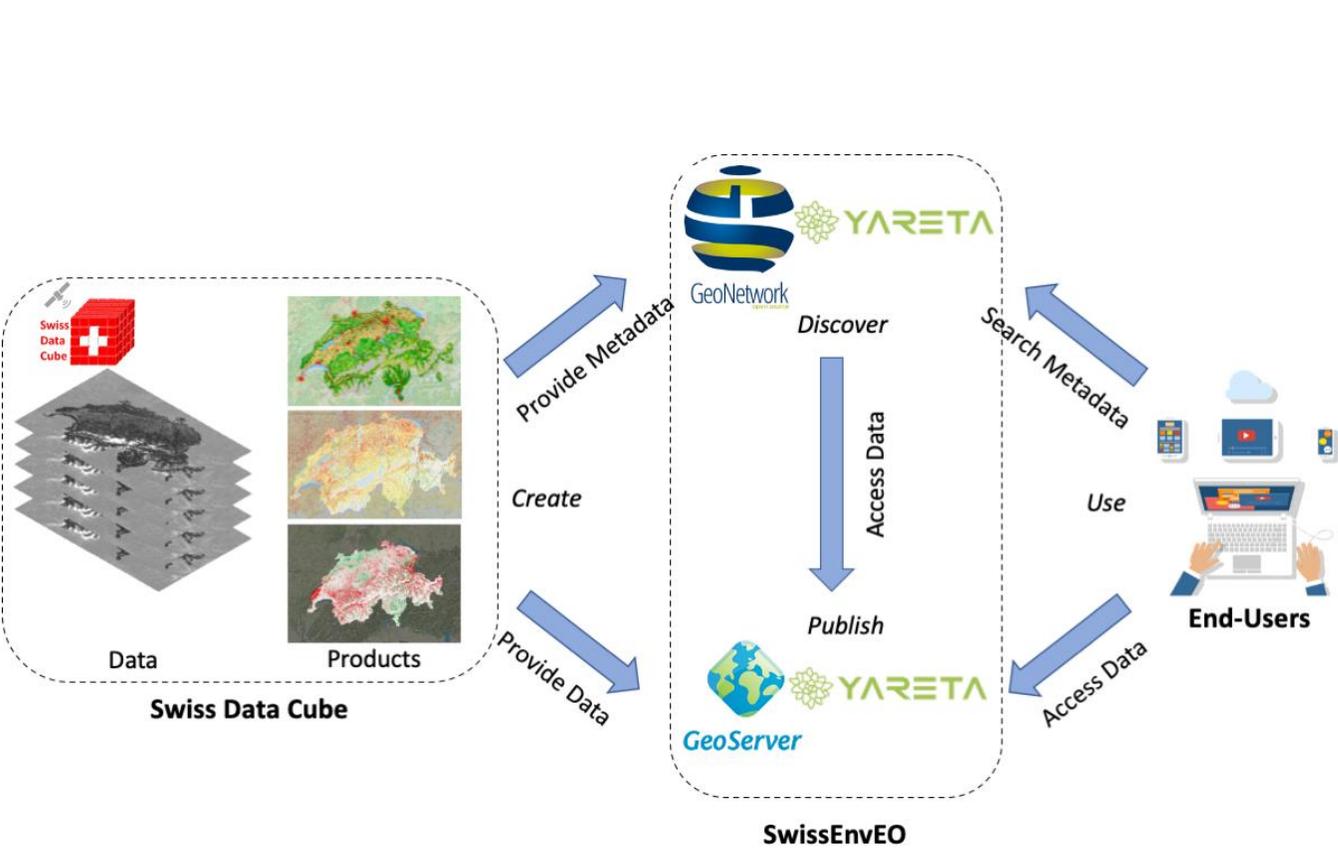
**~40 millions CHF**

COST OF DATA WITHOUT OPEN DATA  
ACCESS POLICY

Chatenoux B., Richard J.-P., Small D., Roeoesli C., Wingate V., Poussin C., Rodila D., Peduzzi P., Steinmeier C., Ginzler C., Psomas A., Schaepman M., Giuliani G. (2021) The Swiss Data Cube: Analysis Ready Data archive using Earth Observations of Switzerland, *Nature Scientific Data*. 8:295 <https://doi.org/10.1038/s41597-021-01076-6>

# SwissEnvEO: une BD environnementale FAIR

<http://geonetwork.swissdatacube.org>



Giuliani G., Cazeaux H. Burgi P.-Y., Poussin C., Richard J.-P., Chatenoux B. (2021) SwissEnvEO: a FAIR national environmental data repository for Earth Observation Open Science, *CODATA Data Science Journal* 20(1):2 <http://doi.org/10.5334/dsj-2021-022>

# Couverture neigeuse mensuelle [1984-2021]

Back to map Previous Next

Download Display mode

## Snow Cover - Monthly [1984-2021]

This dataset is a time-series of monthly snow cover maps over Switzerland computed from Landsat & Sentinel-2 Analysis Ready Data (ARD) for December 1984 to December 2021

These maps quantify the presence/absence of snow using the Snow Observation from Space algorithm developed by Poussin et al. in: <https://doi.org/10.1016/j.srs.2023.100078> and in a submitted paper (Snow Observation from Space: An approach to map snow cover from four decades of Landsat and Sentinel-2 imageries across Switzerland).

Snow cover is an Essential Climate Variables (ECV) playing a significant role in the climate system due to its high albedo and heat insulation. Snow cover also contributes to soil moisture and runoff, making it a crucial variable for monitoring climate change.

Values ranges from 0 to 2. The monthly snow cover products have values ranging from 0 to 2 with the following classification for each pixel:

- 0 when the pixel is snow-free (i.e., land),
- 1 when the pixel is covered with snow,
- 2 when the pixel is covered with clouds (including cloud shadow),
- NA when the pixel is classified as water or lies outside of Switzerland.

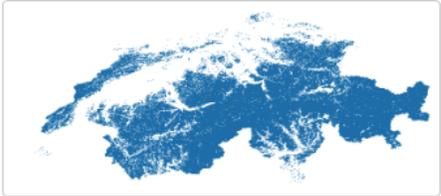
Data format: GeoTiff

Completed

### Download and links

	<b>Snow Cover - Monthly [1984-2021] - Switzerland</b> Yareta Repository <a href="https://doi.org/10.26037/yareta:nq6phdtx45cz5goqxf5qjaei">https://doi.org/10.26037/yareta:nq6phdtx45cz5goqxf5qjaei</a>	Open link
	<b>sdc:snowcover</b> snowcover  This dataset is published in the view service (WMS) available at <a href="https://geoserver.swissdatacube.org/geoserver/ows?service=wms&amp;version=1.3.0&amp;request=GetCapabilities">https://geoserver.swissdatacube.org/geoserver/ows?service=wms&amp;version=1.3.0&amp;request=GetCapabilities</a> with layer name <b>sdc:snowcover</b> .	Add to map

### Overview



### Spatial extent



### Temporal extent

#### Publication date

2024-08-07

#### Period

1984-01-01 ▶▶ 2021-12-31

#### Provided by



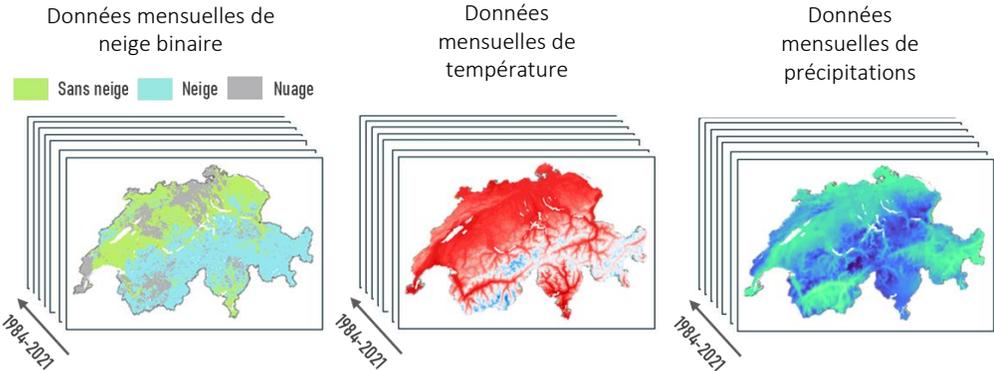
#### Updated:

a year ago

No ratings ★

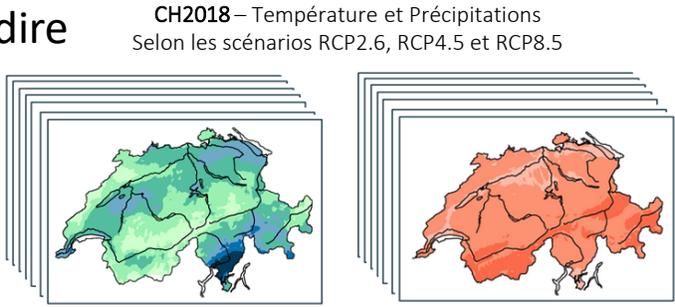


# Probabilités d'observer de la neige basée sur les modèles climatique régionaux (RCP)



GLMM

Prédire

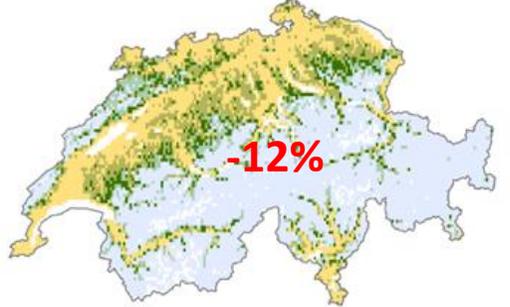


Janvier

Réf.

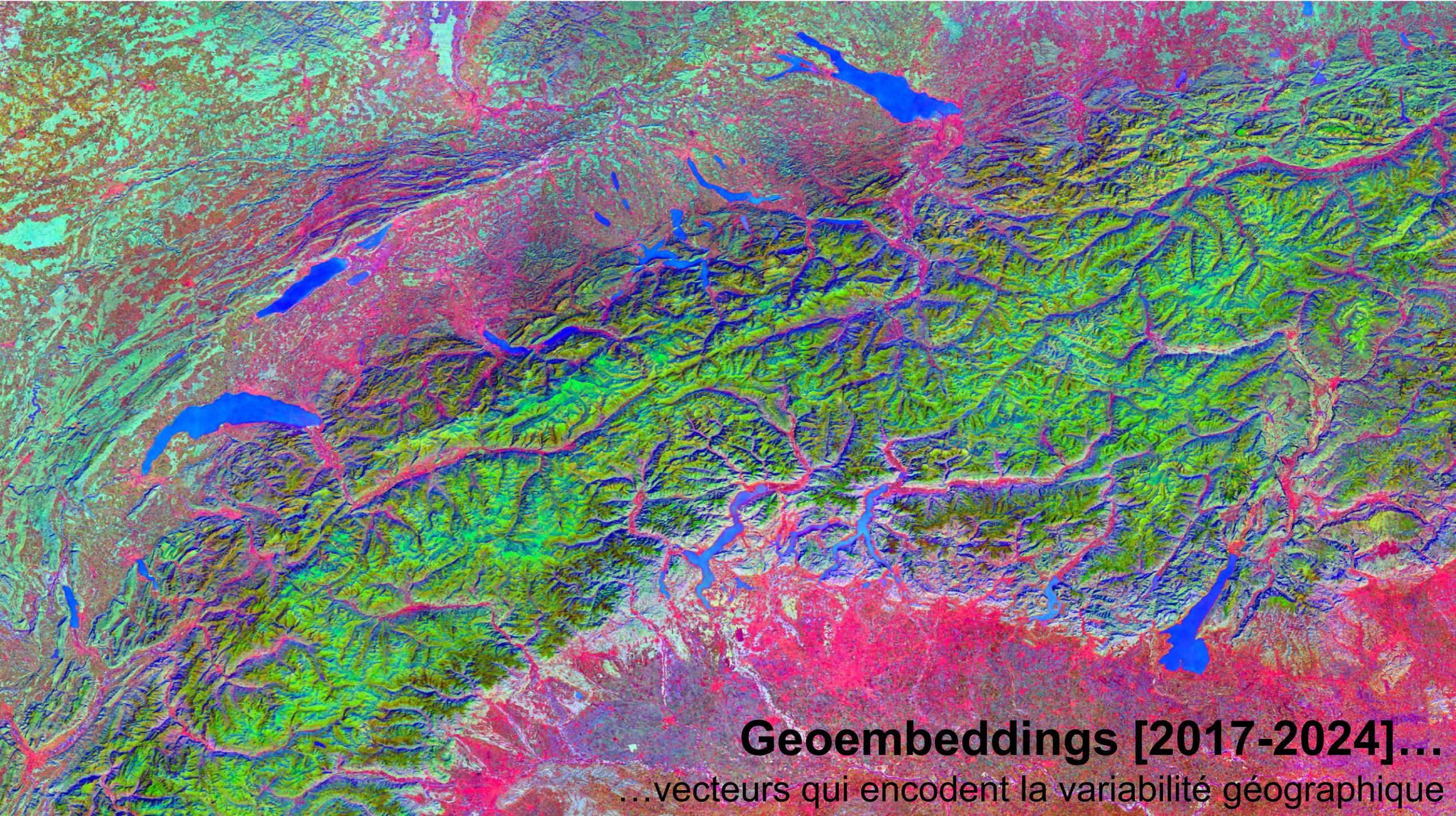


RCP 2.6



RCP 8.5

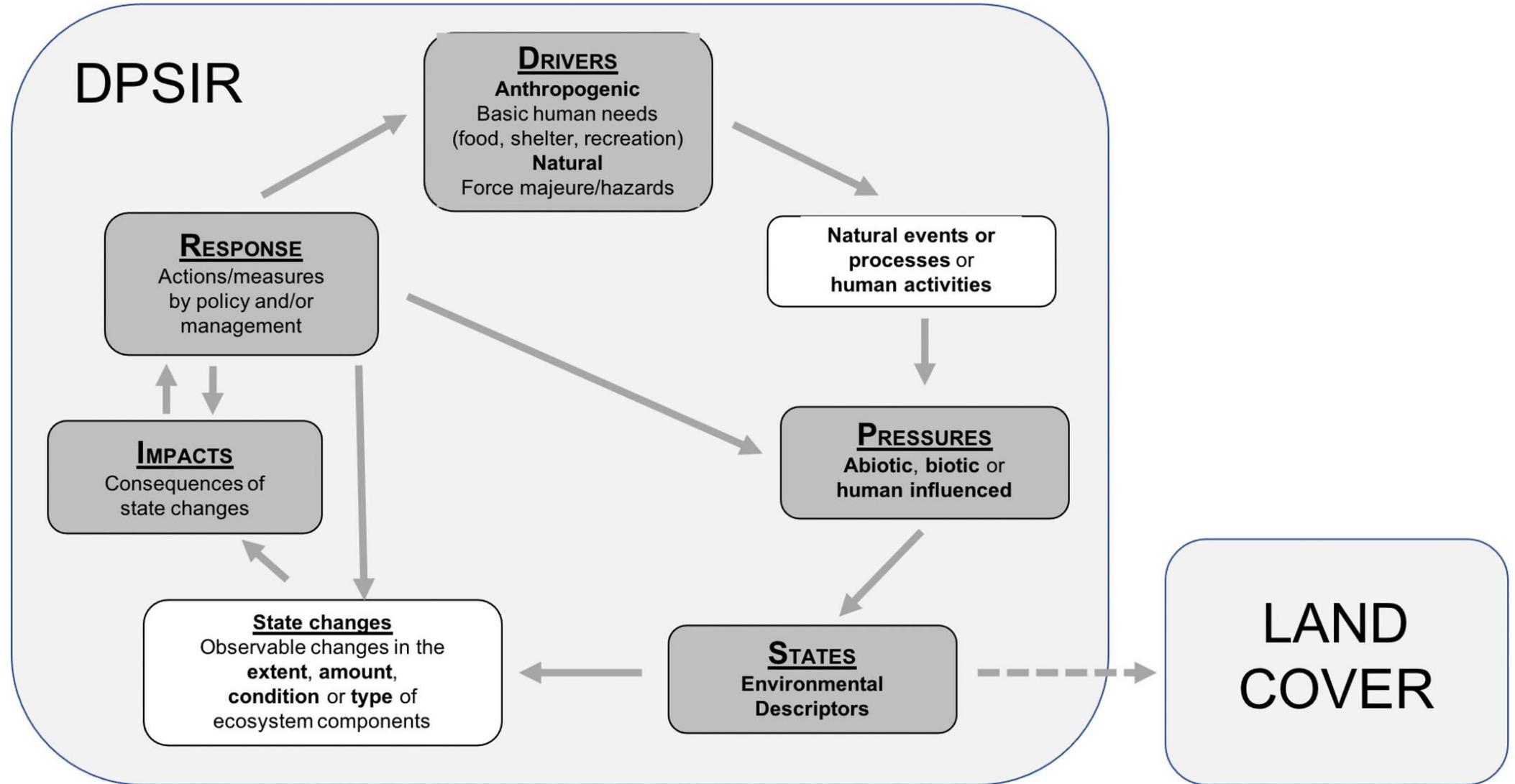




**Geoembeddings [2017-2024]...**  
...vecteurs qui encodent la variabilité géographique

# Comment passer de systèmes qui montrent des états / impacts...

...à un système intégré permettant d'identifier le cadre DPSIR et de prédire les paysages futurs ?



# Jumeau Numérique...

...C'est une représentation virtuelle évolutive d'un objet ou d'un processus, qui utilise les données et les observations provenant de son équivalent physique (Spatial Digital Twins, 2022)

Type of twins	Use before a physical asset exists (predigital twin)	Use after a physical asset exists
Static twin: Model with only static properties	List of digital properties of future products (for example, catalogue data); static model	List of digital properties of an actual product; static model
Functional twin: Static twin including some dynamic behavior capabilities (also called a <i>mirror</i> <sup>1</sup> )	Model usable for simulations of what is likely to happen; useful when prototyping a physical asset	Model usable for simulations of what is likely to happen and smart features, comparing the behavior of a real physical asset and the simulated version from the twin
Self-adaptive digital twin: Functional twin with capacity to acquire real-time data and update the model (also called a <i>shadow</i> <sup>1</sup> ); needs a digital thread <sup>1</sup> keeping track of evolution and communication with physical twin and following the lifecycle of the digital twin	Model with adaptive capabilities in regard to system level test conditions and scenarios to optimize an asset choice	Synchronization with real-time data to refine a twin's capabilities and expected behavior and make it as close as possible to the real asset; model usable for predictions, maintenance, and simulations of what is actually happening with the physical twin
Intelligent digital twin: Self-adaptive digital twin with autonomy, learning, reasoning, knowledge, and acting capabilities; able to communicate with other twins (also called an <i>extended digital twin</i> , <i>cognitive digital twin</i> or <i>physical avatar</i> <sup>1</sup> ); needs information exchange between physical and digital twin in both directions	Selection and prototyping of the right asset; could take the place of physical asset-to-be in prototyping and simulation involving an ecosystem combining other physical assets and twins	Twin becomes an autonomous software agent equipped with learning, sensing, acting, and autonomous capabilities; exchanges data with a physical asset in a feedback loop and with other twins, takes actions alongside or on behalf of physical twin or complements it; could even discover on the fly new capabilities and lead to better use of a physical asset or replace the asset itself (for example, self-healing)

# DESTINATION EARTH



## A DIGITAL REPLICAF OF OUR PLANET

Destination Earth (**DestinE**) aims to develop a highly accurate digital model of Earth to monitor the effects of natural and human activity on our planet, anticipate extreme events and adapt policies to climate-related challenges.



# Living Switzerland...

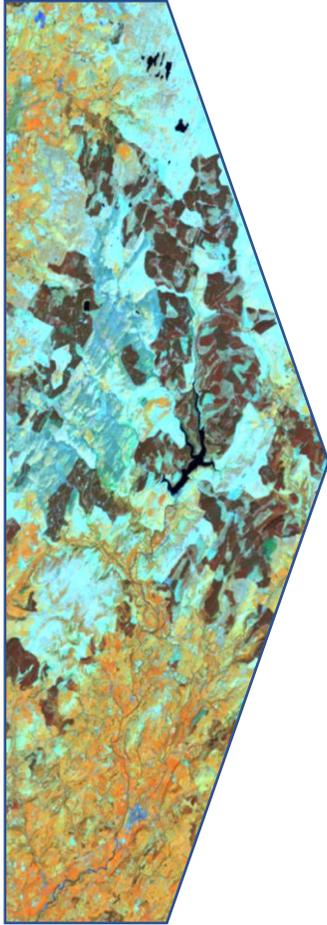
*...une capacité unique à capturer des informations cohérentes et évolutives sur les états et la dynamique des paysages passés et présents, afin d'éclairer la planification du futur*



# Living Earth – Concept & Approche

DIGITAL INFRASTRUCTURE (BASED ON THE OPEN DATA CUBE)

Earth Observation Data  
Acquisition and Processing to an Analysis Ready Format

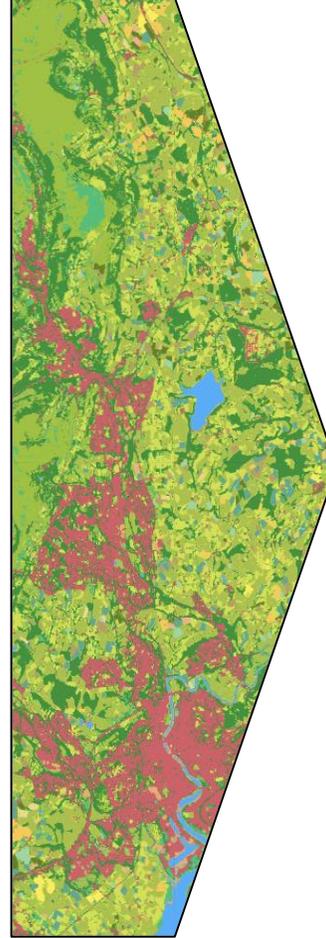


Environmental Descriptors



Classifications of land cover and habitats

Historical and near real time



Evidence-based change



Future Landscapes



Delivery

Policy, Economy, Environment and Society

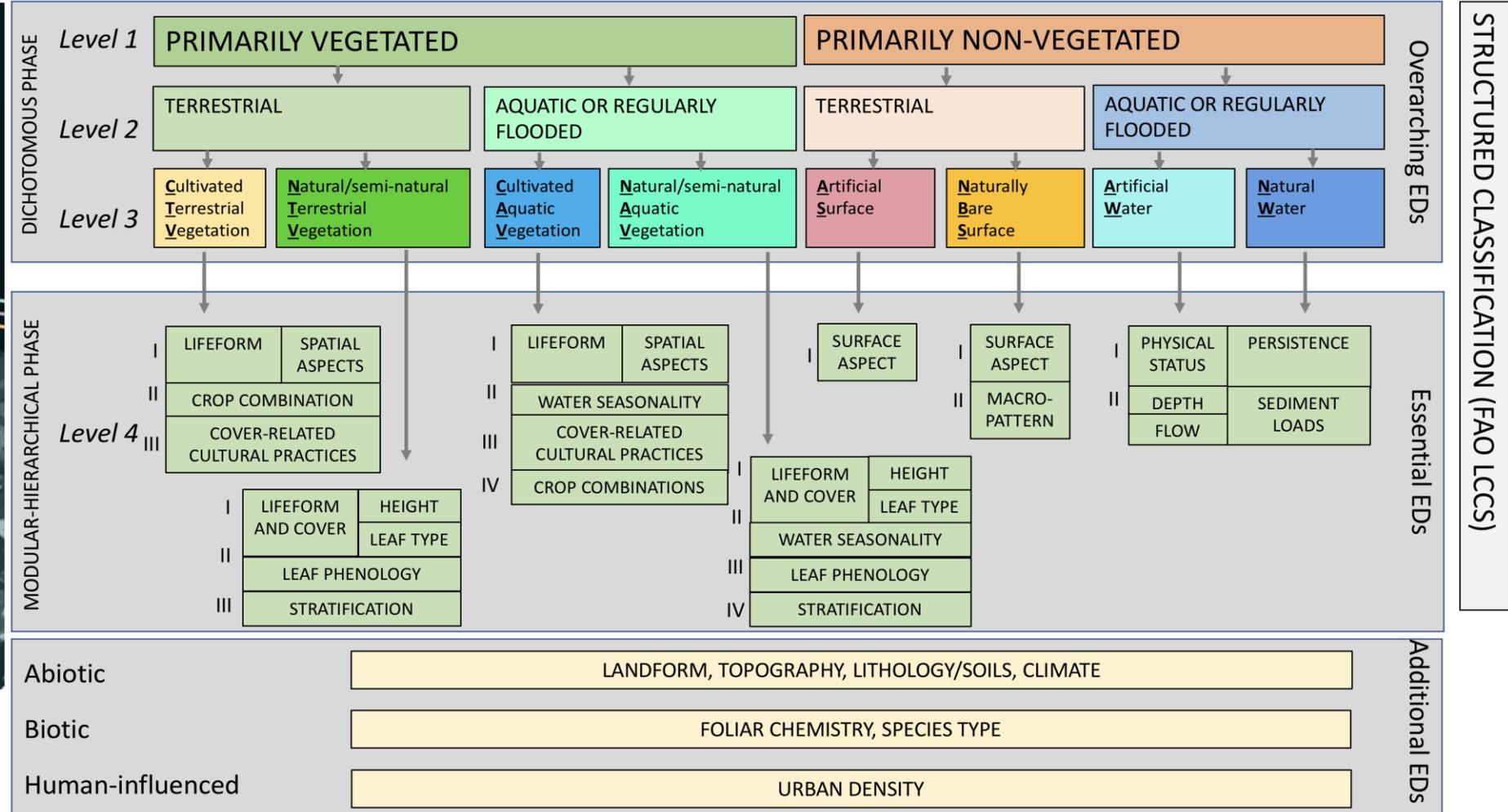
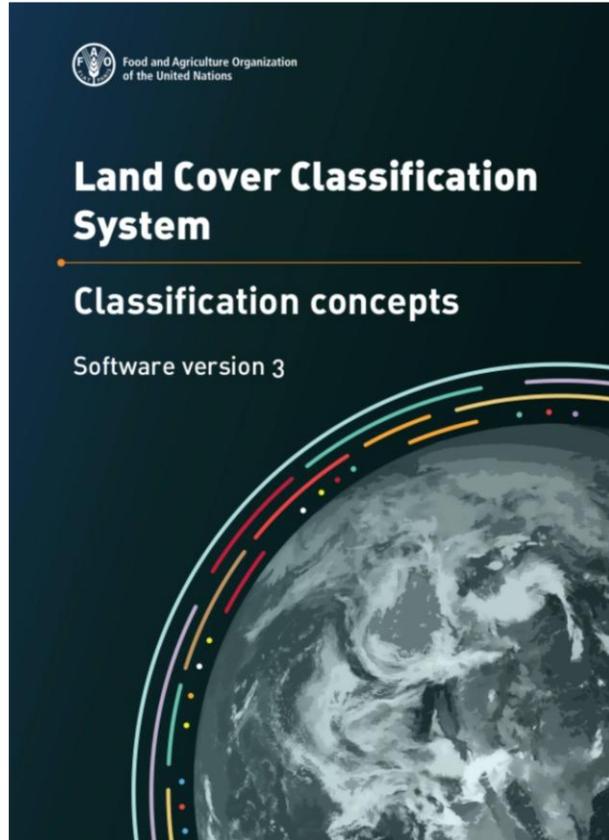


Calibration and Validation

ENGAGEMENT (E.G. ACADEMIA, GOVERNMENTS, RESEARCH AND SPACE AGENCIES, NGOS, LANDHOLDERS)

# Classification - couverture du sol

*Living Earth* construit de façon unique des classes de couverture du sol à partir de descripteurs environnementaux issus principalement des données d'observations de la Terre, selon le système LCCS de la FAO.



# Descripteurs environnementaux

## Vegetation



**Leaf Area Index ( $m^2 m^{-2}$ )**  
The total area of one side of leaves per unit of ground surface area. Governs processes such as photosynthesis.



**Fraction of Absorbed Photosynthetically Active Radiation (%)**  
The energy absorption capacity of vegetation. FAPAR represents the growing capacity of canopies.



**Canopy Height (m)**  
The height of vegetation (woody or herbaceous) above the terrain surface. Influences energy balance and ecosystem function.



**Canopy Cover (%)**  
The fraction of ground covered by green vegetation. Canopy cover describes the horizontal distribution of plant material.



**Lifeform (class)**  
Groups of plants based on structural similarities. Examples are woody trees and shrubs, herbaceous forbs and graminoids and lichens/mosses.



**Leaf Type (class)**  
Groups of plants having similar leaf morphology. The main classes are broadleaf, needleleaf and *apophyllous* (e.g., gorse).



**Phenology (Day of Year)**  
The timing of the vegetation life-cycle including budburst, flowering, leaf senescence and leaf fall.



**Gross Primary Productivity ( $gC m^{-2} day^{-1}$ )**  
The amount of carbon uptake by plants per unit time through photosynthesis.



**Net Primary Productivity ( $gC m^{-2} day^{-1}$ )**  
The net amount of carbon uptake after subtracting plant respiration from Gross Primary Productivity over a period of time.



**Woody Biomass ( $Mg ha^{-1}$ )**  
The total mass of woody plant material per unit area. Can consider both above and below ground components.



**Plant genus or species (presence/absence or probability)**  
An indicator of genetic diversity and both floral and faunal diversity and environmental change.



**Crop Type (class)**  
The dominant crop species, whether as a monoculture or mixed cultivation. Indicator of water management, plant health and biodiversity.



**Vegetation Moisture ( $g m^{-2}$ )**  
The amount of water per unit area of leaf. Key indicator of vegetation water stress.



**Foliar Chemistry ( $g cm^{-2}$ )**  
The chemical content of leaves. Includes chlorophyll a and b, carotenoids, anthocyanin, nitrogen and carbon.



**Burnt Area ( $ha$  or  $km^2$ ), Timing (date and period) and Severity**  
Extent of natural or human-induced burns, severity of burns and date of fires. Influenced by fire fuel loads and moisture conditions.



**Herbaceous Biomass ( $Mg m^{-2}$ )**  
The total mass of living plants that have a non-woody stem, per unit area. An indicator of plant productivity.



**Canopy Layers (count)**  
The distribution of plant material within the vertical profile. Often used to differentiate layers such as the ground floor, understorey and overstorey.



**Non Photosynthetic Vegetation (%)**  
The amount of dormant or senescent plant material. Indicator of biodiversity and fuel loads.

## Defined Categories



### CROP TYPE

The crop type is the type of plants cultivated in the fields during the main growing season. The crop type can be, for example, maize, potatoes, etc. The type of crops is important for various applications such as hydrological modelling, plant health, crop science, environment monitoring, biodiversity safeguard, etc. Indeed, the type of plants directly...

[READ MORE](#)

## Defined units



### WOODY BIOMASS

Woody biomass is defined as the total mass of living plant material per woody area. Aboveground biomass plays a key role in the carbon cycle and climate processes. It can be measured through direct or indirect in situ sampling (see here) or estimated through satellite/airborne sensors. Typically, biomass in woody areas ranges between 0 (poorly)...

[READ MORE](#)

## Marine



**Bathymetry (m)**  
Depth of the floor of water bodies and a measure of underwater relief.



**Sea Surface Temperature (K or  $^{\circ}C$ )**  
The temperature of the uppermost (exposed) mixed layer of the ocean. SST is a key variable affecting various biological and climate processes.



**Sea Surface Salinity (PSU or PPT; g of salt per kg of water)**  
The salt concentration in seawater and an indicator of biological diversity and freshwater inputs.



**Net Primary Productivity ( $gC m^{-2} day^{-1}$ )**  
The net amount of carbon uptake of the ocean through photosynthesis by algae and phytoplankton. NPP measures the productivity of marine vegetation.



**pH (range 0 to 14)**  
A measure of the acidity of oceans, with pH values < 7 representing high acidity and those > 7 identifying alkaline waters.



**Chemistry ( $g m^{-3}$  or  $mol m^{-3}$ )**  
The concentration of elements (e.g., oxygen, carbon and phosphate) in the marine water.



**Chlorophyll ( $g m^{-3}$ )**  
The amount of chlorophyll contained within phytoplankton in marine waters. An indicator of marine plant productivity.



**Colored Dissolved Organic Matter ( $m^{-1}$ )**  
The absorption coefficient of various organic materials in the sea water. Higher CDOM reduces light penetration in the water.



**Total Suspended Matter ( $g m^{-3}$ )**  
A measure of water turbidity. TSM includes both organic and mineral particles and affects light conditions in the water and the distribution of flora and fauna.

## Snow



**Snow Cover Fraction (%)**  
The fraction of land area covered by snow. SCF strongly influences surface energy balance, albedo and floral/faunal distributions and functioning.



**Snow Water Equivalent (mm)**  
The amount of water contained within the snowpack. SWE correlates with snowpack depth and snow density.



**Snow Depth (cm)**  
The depth of the snowpack. An indicator of water retention in snow. Links to flood events associated with snow melt.

## Water



**Water Turbidity (NTU)**  
The measure of water transparency as well as quality. Drinking water should have less than 5 NTU turbidity.



**Water Depth (m)**  
The depth of the floor of water bodies. Influences the amount of sunlight reaching the floor and hence the life cycles of aquatic organisms.



**Water Seasonality (days or months)**  
The persistence of water on the surface. Influenced by terrain relief, soil permeability, geological and geomorphological formations and precipitation rates.

## Soil



**Soil Moisture ( $m^3 m^{-3}$ )**  
The volume of water contained within soils. Soil moisture status can influence levels of vegetation water stress and flood risk.



**Soil Acidity (pH scale)**  
A measure of the acidity of soils, with pH values < 7 identified as acidic and those > 7 being more alkaline. Influences species abundance, distributions and productivity.



**Soil Texture (class)**  
Soil can be classified into textural classes including loams, clays and sands. Textural composition influences water holding capacity and dynamics and vegetation stress levels.

## Urban



**Artificial Material (% area<sup>-2</sup>)**  
Man-made impervious surfaces including buildings, roads, railways and quarries. These surfaces strongly modify hydrology, climate and biodiversity.



**Urban Vegetation (% area<sup>-2</sup>)**  
Includes vegetation in playgrounds, parks and gardens. Influences local weather conditions, hydrology and biodiversity.

## Energy



**Albedo (%)**  
The ratio of total upwelling to total downwelling solar radiation. Albedo influences land surface temperature, weather and climate.



**Land Surface Temperature (K or  $^{\circ}C$ )**  
The radiative skin temperature of the land. LST strongly influences land surface processes and energy balance.

## Terrain



**Digital Elevation Model (m)**  
Digital Terrain Models (DTMs) represent the elevation of bare terrain whilst Digital Surface Models (DSMs) represent the upper height of all objects on the land surface.



**Slope ( $^{\circ}$ )**  
The steepness or degree of inclination of ground to the plane surface. Ranges from 0 to 90 $^{\circ}$  and influences wind speeds and directions and hydrological flows.



**Aspect ( $^{\circ}$ )**  
The orientation of slope, measured clockwise from north (0 to 360 $^{\circ}$ ). Along with slope, aspect regulates land surface processes including plant productivity, climate and hydrology.

## Atmosphere



**Climate Variables**  
Climate variables include solar radiation, rainfall, air temperature and humidity, pressure, and wind speed and direction. Long term trends of these variables indicate past climatic conditions.

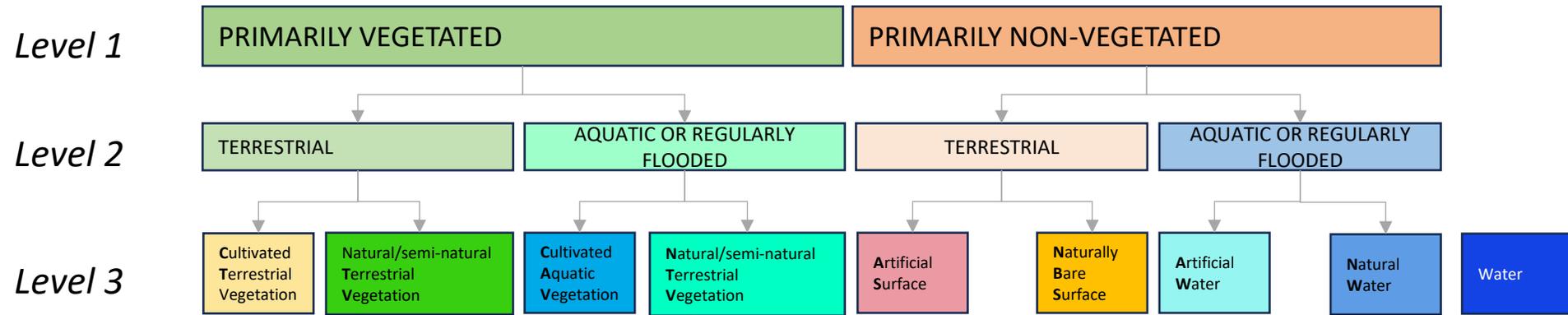
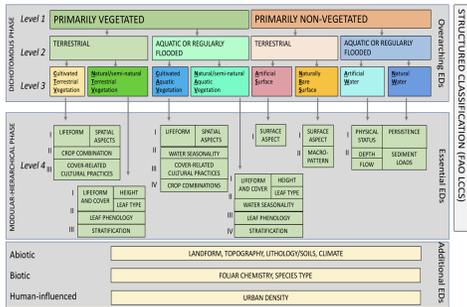


**Air pollutants (ppm or  $\mu g m^{-3}$ )**  
Includes gases (nitrous oxide, ammonia, sulfur dioxide) and particulate matter. Their concentrations inform about air quality. A key influence on plant and animal health.

# Couverture du sol – Niveau 3



Formes générales



## Broad description (Level 3)

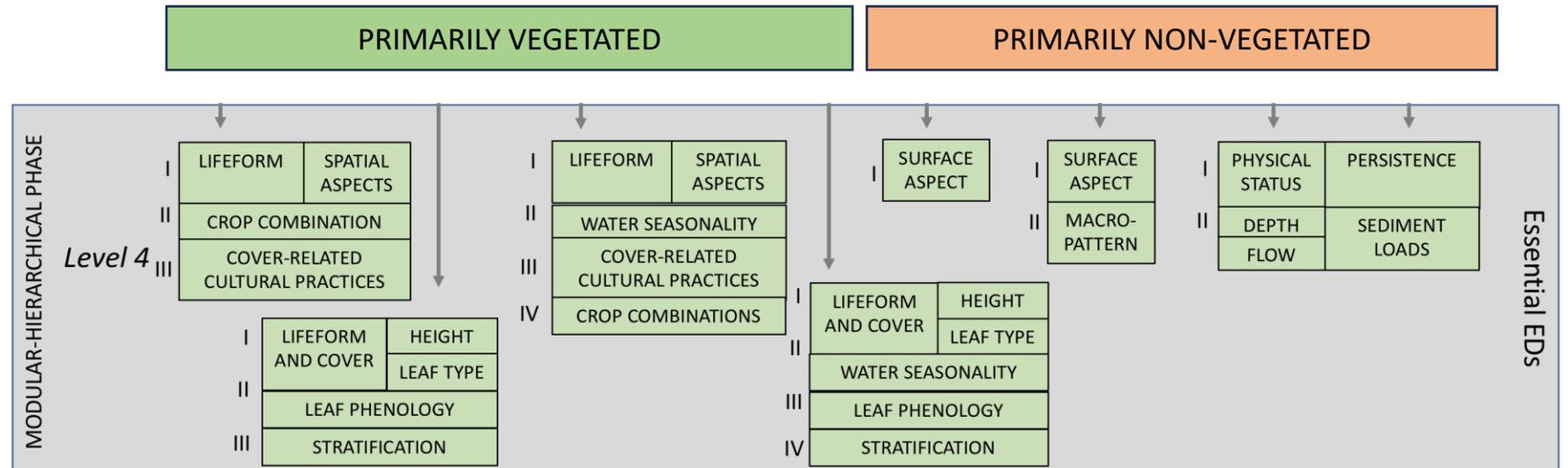
- 'Natural' Terrestrial Vegetation

# Couverture du sol – Niveau 4

Descripteurs Environnementaux Essentiels  
*Needed to fully construct the FAO LCCS*



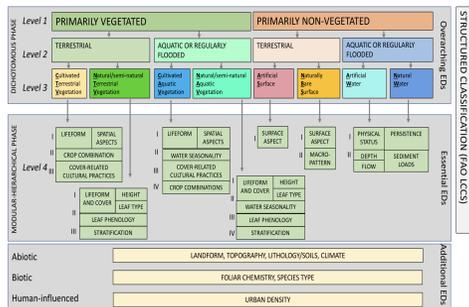
Ajout de détails



STRUCTURED CLASSIFICATION (FAO LCCS)

## More detail (Level 4)

- Woody shrub
- Canopy cover (40-65 %)
- Canopy height (0.5 m)
- Broadleaved
- Evergreen
- No second layer
- Not waterlogged



# Couverture du sol – Niveau 5

Descripteurs Environnementaux Additionels



Ajout des dernières touches et du cadre

PRIMARILY VEGETATED



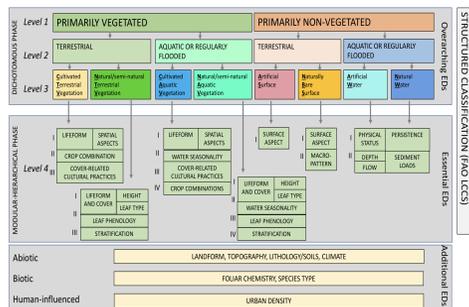
PRIMARILY NON-VEGETATED



Abiotic	LANDFORM, TOPOGRAPHY, LITHOLOGY/SOILS, CLIMATE	Additional EDs
Biotic	FOLIAR CHEMISTRY, SPECIES TYPE	
Human-influenced	URBAN DENSITY	

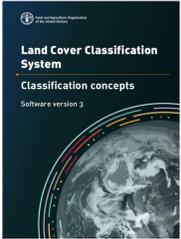
## Additional information

- Above ground biomass (10 kg)
- Canopy cover (55.5 %)
- Species A



# Living Earth - Analyses

Environmental descriptors used to construct land cover classes



Defined units or categories

## Broad description

'Cultivated' Terrestrial Vegetation

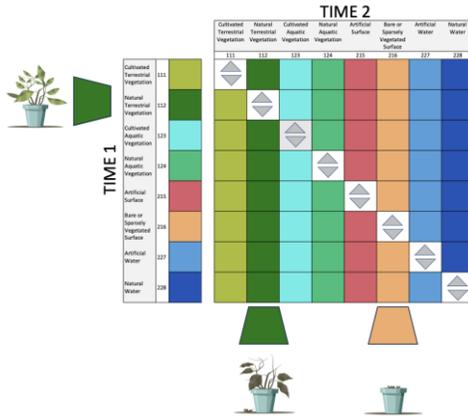
## More detail

- Woody shrub
- Canopy cover (40-65 %)
- Canopy height (0.5 m)
- Broadleaved
- Evergreen
- No second layer
- Not waterlogged

## Additional information

- Above ground biomass (10 kg)
- Canopy cover (55.5 %)
- Species A

## I: Observed change



**Modification** (on-diagonal)      **Conversion** (off diagonal)

**NATURAL TERRESTRIAL VEGETATION**  
 Trees closed canopy (> 65 %) tall (>14 m) broadleaved evergreen with an understory; canopy cover of 72 ( $\pm 5$ ) %, above ground biomass of 170 ( $\pm 15$ ) Mg ha<sup>-1</sup>, dominated by European beech (*Fagus sylvatica*)  
**A12. A3.A10.B5.D2.E2.F1**  
 -72 ( $\pm 5$ ), 170 ( $\pm 15$ ), 676

**NATURAL TERRESTRIAL VEGETATION**  
 Trees closed canopy (< 10 %) tall (< 2m) broadleaved evergreen with no understory; canopy cover of 50 ( $\pm 10$ ) %, above ground biomass of 15 ( $\pm 5$ ) Mg ha<sup>-1</sup>, dominated by Birch (*Betula pendula*)  
**A12.A3.A15.B8.D2.E2.F2**  
 -50 ( $\pm 10$ ), 15 ( $\pm 5$ ), 144

## II: Evidence for impacts



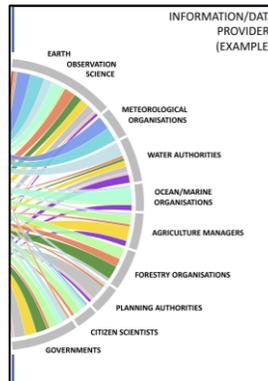
Gathering through time-series comparison of environmental descriptors

Vegetation dieback	
Level 3:	
CTV to CTV	NTV to NTV
CAV to CAV	NAV to NAV
A: Lifeform:	
Remains woody	Remains herb.
A: Canopy cover	
Decrease in canopy cover	
B: Canopy height:	
Decrease in forest height	
D: Leaf type:	
Remains Bleaf	Remains Nleaf
E: Phenology	
Remains evergreen	Remains deciduous
Canopy cover (Range 0-100 %):	
Decrease in canopy cover	
AG Biomass (Range 0 - > 500 Mg ha <sup>-1</sup> )	
No change or decrease in AGB	

## III: Identifying and evidencing pressures

- Anchoring
- Cold snap
- Drought
- Heatwave
- Increased wind
- Non-insect herbivory (natural)
- Pathogens
- Pollution
- Prolonged inundation
- Prolonged snow cover
- Sea level fluctuation
- Soil salinisation
- Water salinization\*

Different pressures linked to impacts



Sources of pressure data

## IV: Linking impacts with pressures



Dieback (strong winds)



Dieback (pathogens)

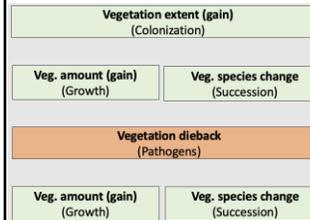


Dieback (sea level fluctuation)



Dieback (bushfire)

Sequential and/or simultaneous



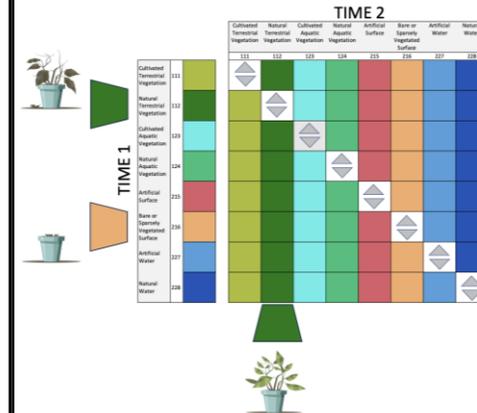
Impact (pressure)

## V: Future landscapes

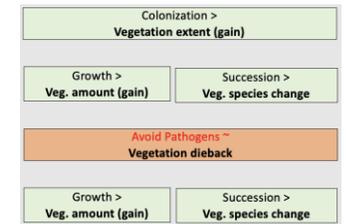


Visioning

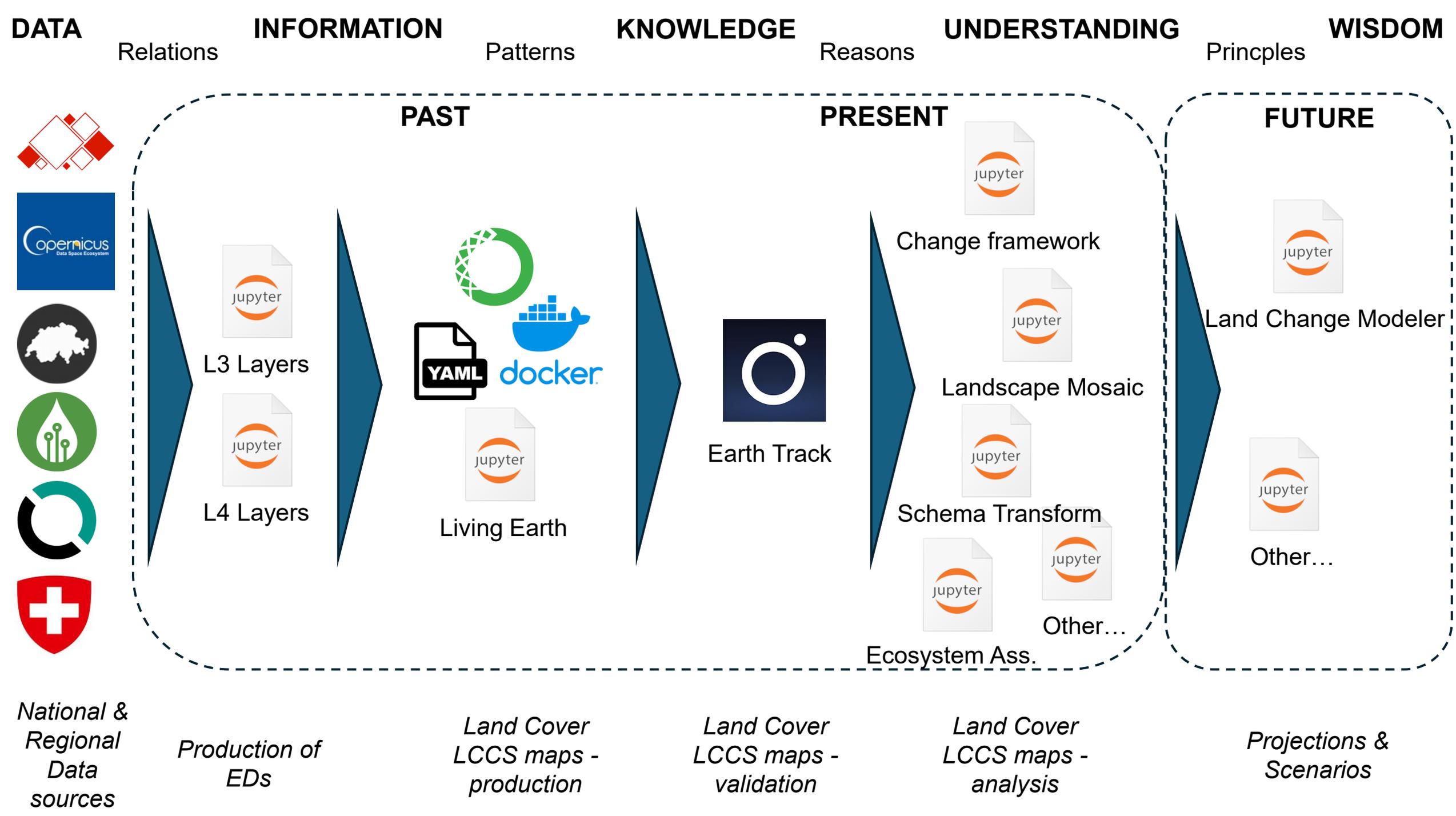
Designing landscapes



Planning Actions



Pressure > Impact

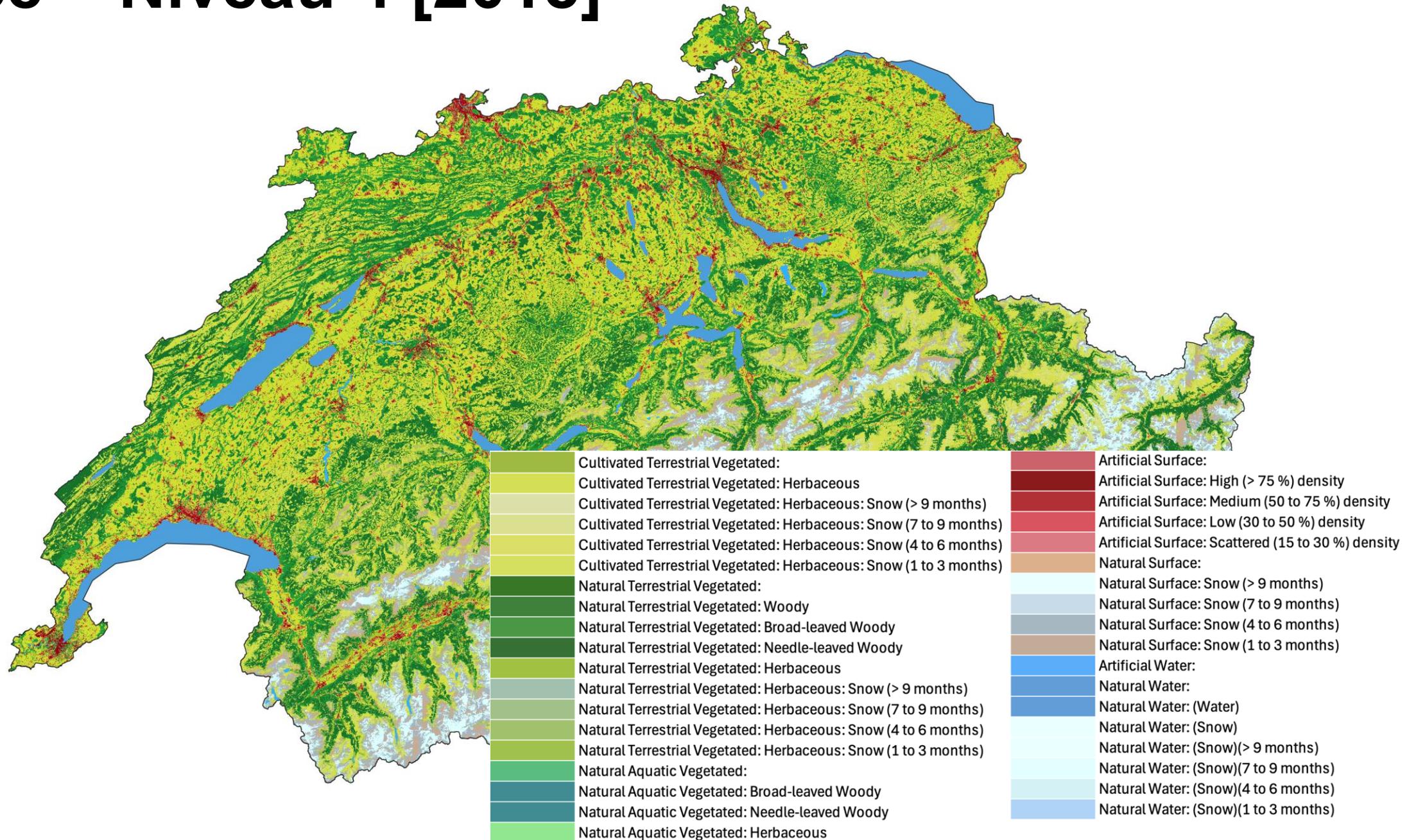


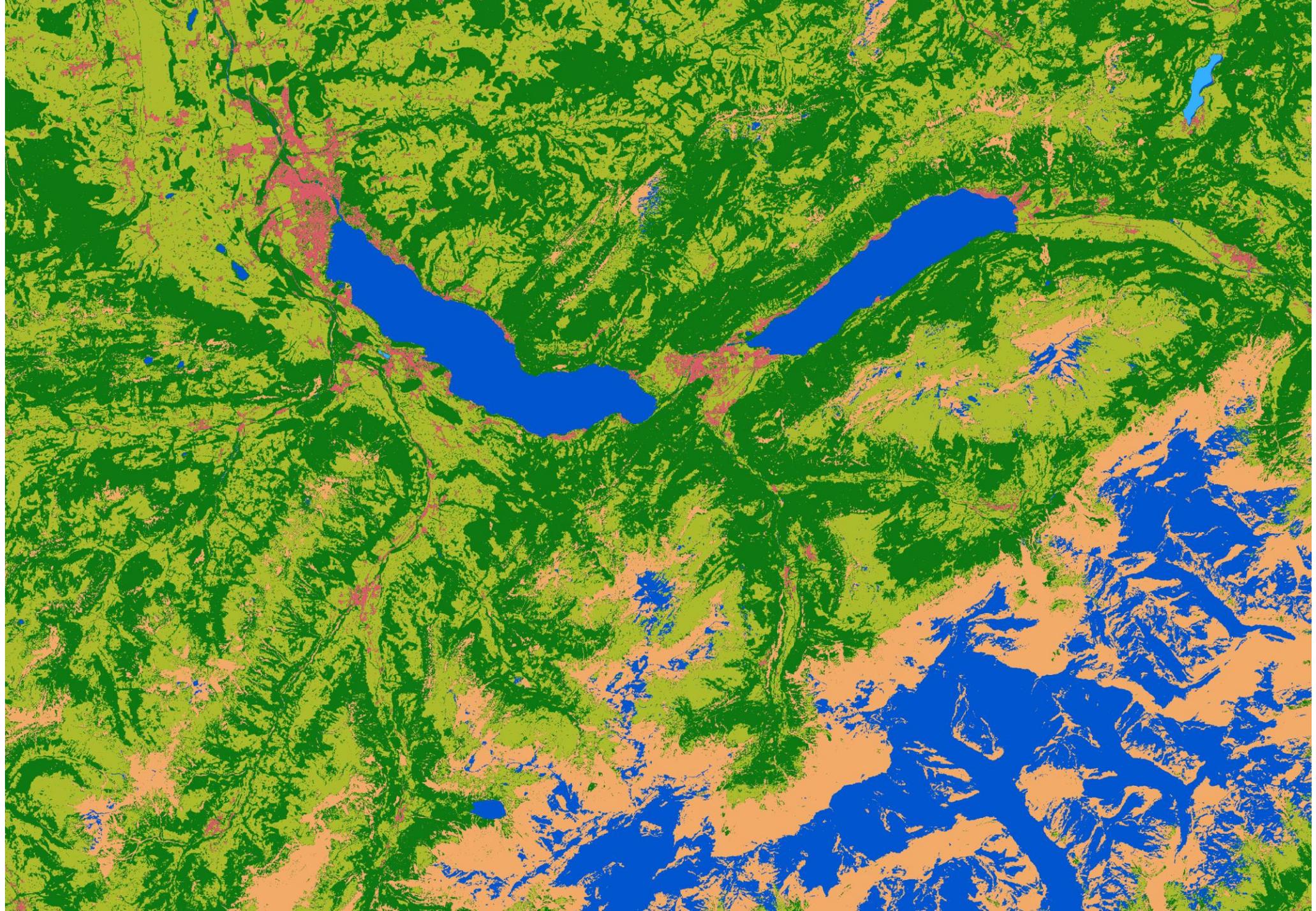
# Suisse – Niveau 3 [2018]

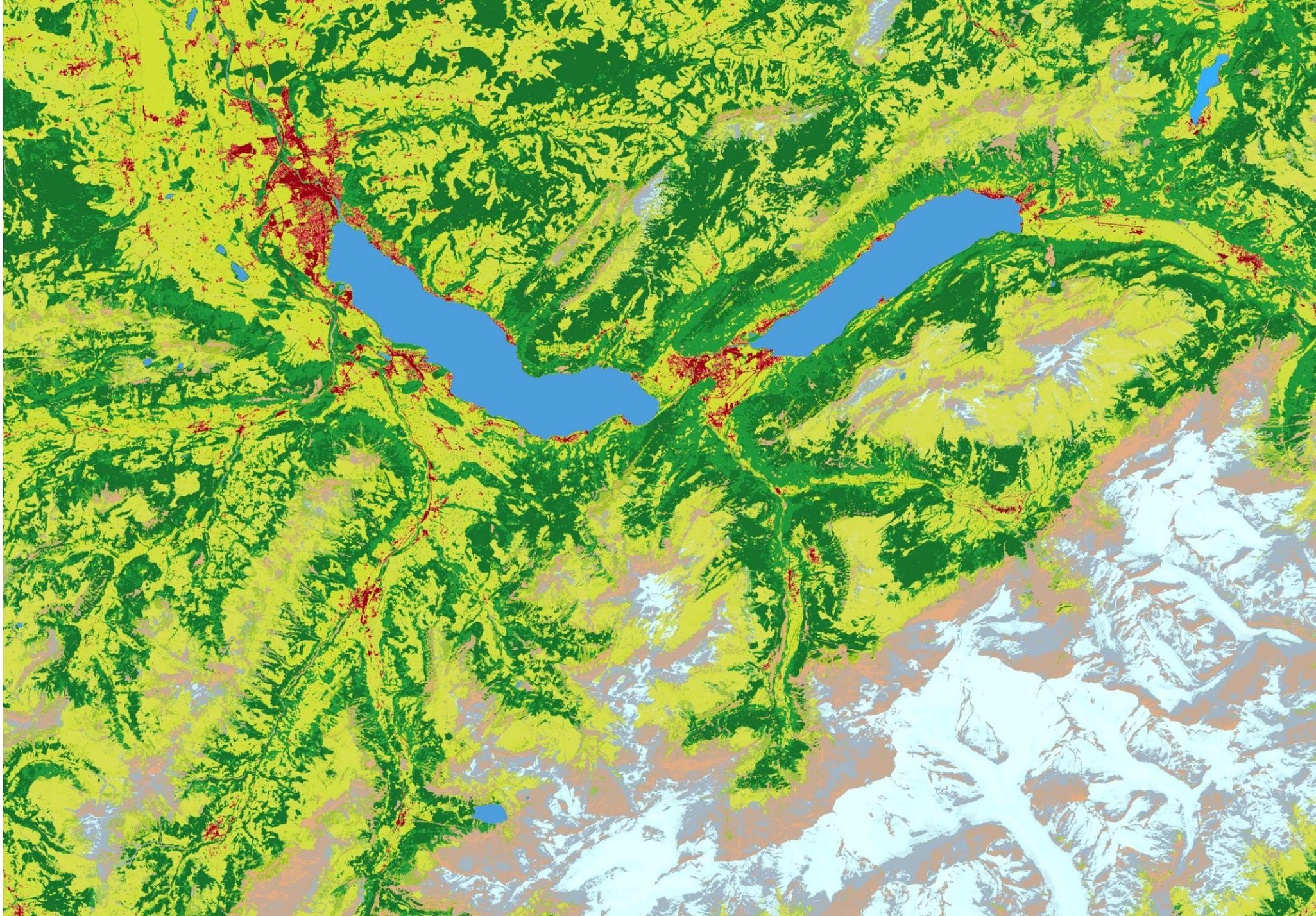


- Cultivated Terrestrial Vegetated
- Natural Terrestrial Vegetated
- Cultivated Aquatic Vegetated
- Natural Aquatic Vegetated
- Artificial Surface
- Bare Areas
- Artificial Water
- Natural Water

# Suisse – Niveau 4 [2018]









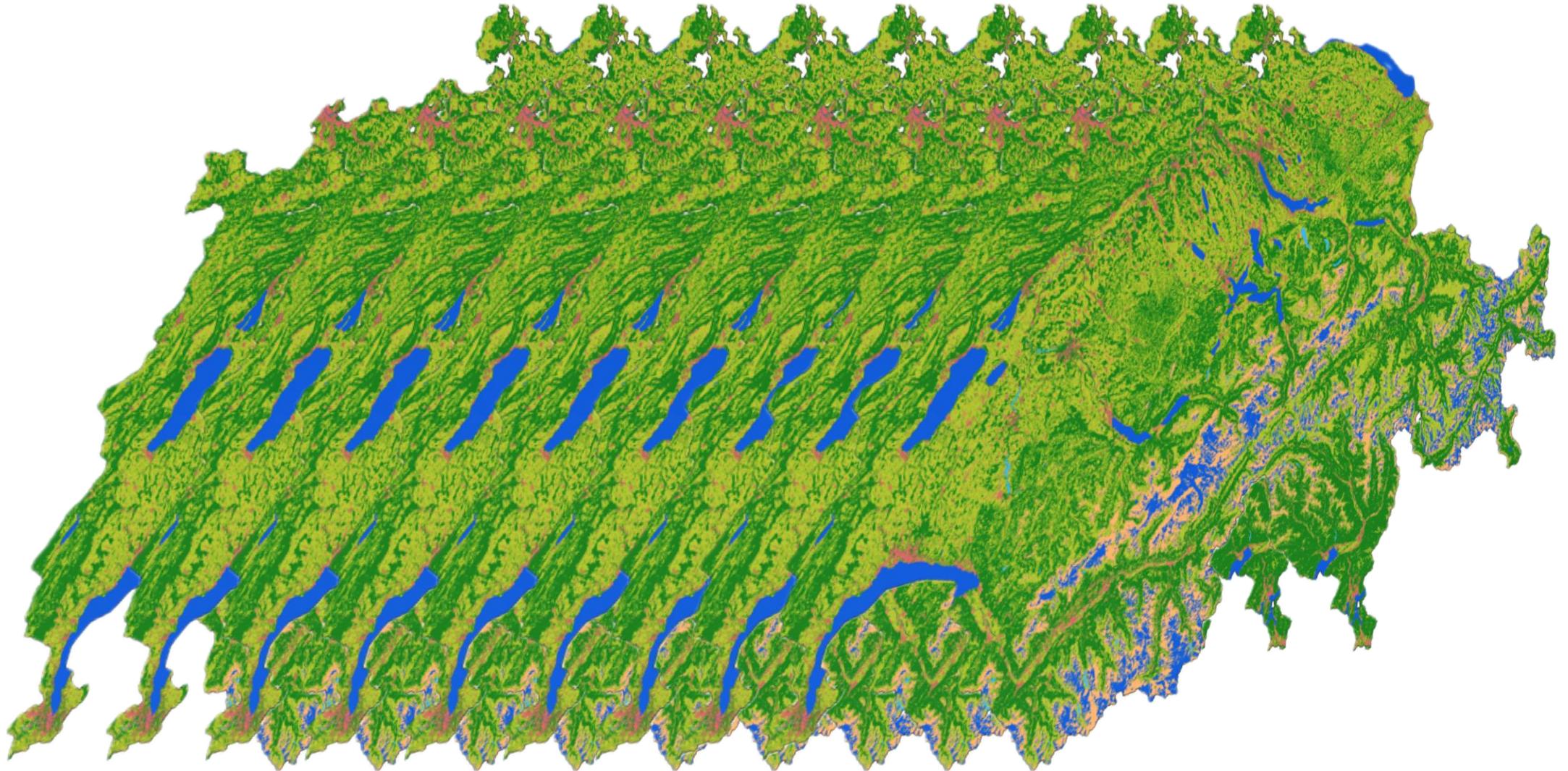
# Suisse – Descripteurs environnementaux [2018]

LCCS4 layers	Definition	Source & method for data prep
artisurf_urb_cat	artificial surface (urban built up or non-built up)	SDC/Copernicus
mnolinea_urb_cat	non-linear surfaces (e.g., industrial)	TLM
martdens_urb_cat	Urban density (e.g. high, medium, low, scattered) (%)	SDC/Copernicus
urbanveg_urb_cat	urban vegetation type (e.g., parks, lawns)	TLM
lifeform_veg_cat	woody (trees, shrubs), herbeaceous (graminoids, forbs) & cryptograms (lichens, mosses)	WSL
canopyht_veg_con	Canopy height (m)	NFI
canopyco_veg_con	Canopy cover (%)	SDC/Copernicus
leaftype_veg_cat	broad-leaved, needle-leaved or aphyllous	SDC/Copernicus
phenolog_veg_cat	evergreen, deciduous, mixed, mixed (forbs, graminoids)	NFI
cropseqt_agr_cat	crop sequences for cultivated terrestrial vegetation	
spatdist_veg_cat	spatial distribution (fragmented or continuous)	
baresurf_phy_cat	bare surface materials (consolidated or unconsolidated)	TLM
waterstt_wat_cat	water state (water, ice or snow)	SDC
snowcper_wat_cin	Snow persistence (hydroperiod) (days)	SDC
watersea_veg_cat	water seasonality in (semi-)natural areas	SDC/Copernicus

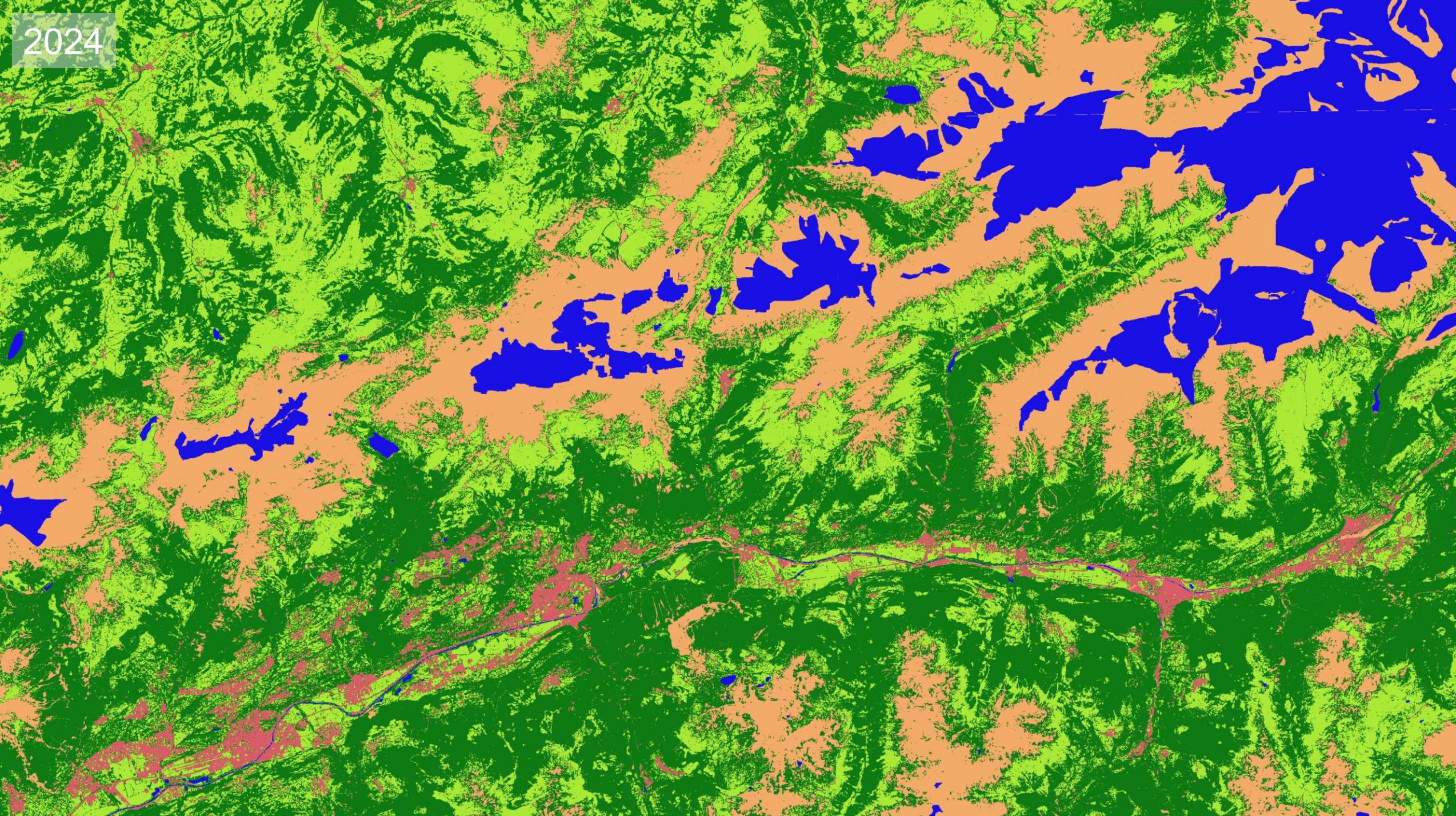
LCCS3 layers	Definition	Source & method for data prep
vegetat_veg_cat	Binary column indicating the present (or otherwise) of vegetation.	SDC
aquatic_wat_cat	Binary column indicating the present (or otherwise) of an aquatic land cover (e.g., water).	SDC/Copernicus
cultman_agr_cat	Binary column indicating the present (or otherwise) of cultivation.	WSL
artific_urb_cat	Binary column indicating the present (or otherwise) of Urban areas.	SDC/Copernicus
artwatr_wat_cat	Binary column indicating the present (or otherwise) of artificial water bodies.	BAFU

# Données annuelles & quantifier les changements

...1984-2024 (Landsat) – 30m & 2018-2024 (Sentinel-2) – 10m



2024

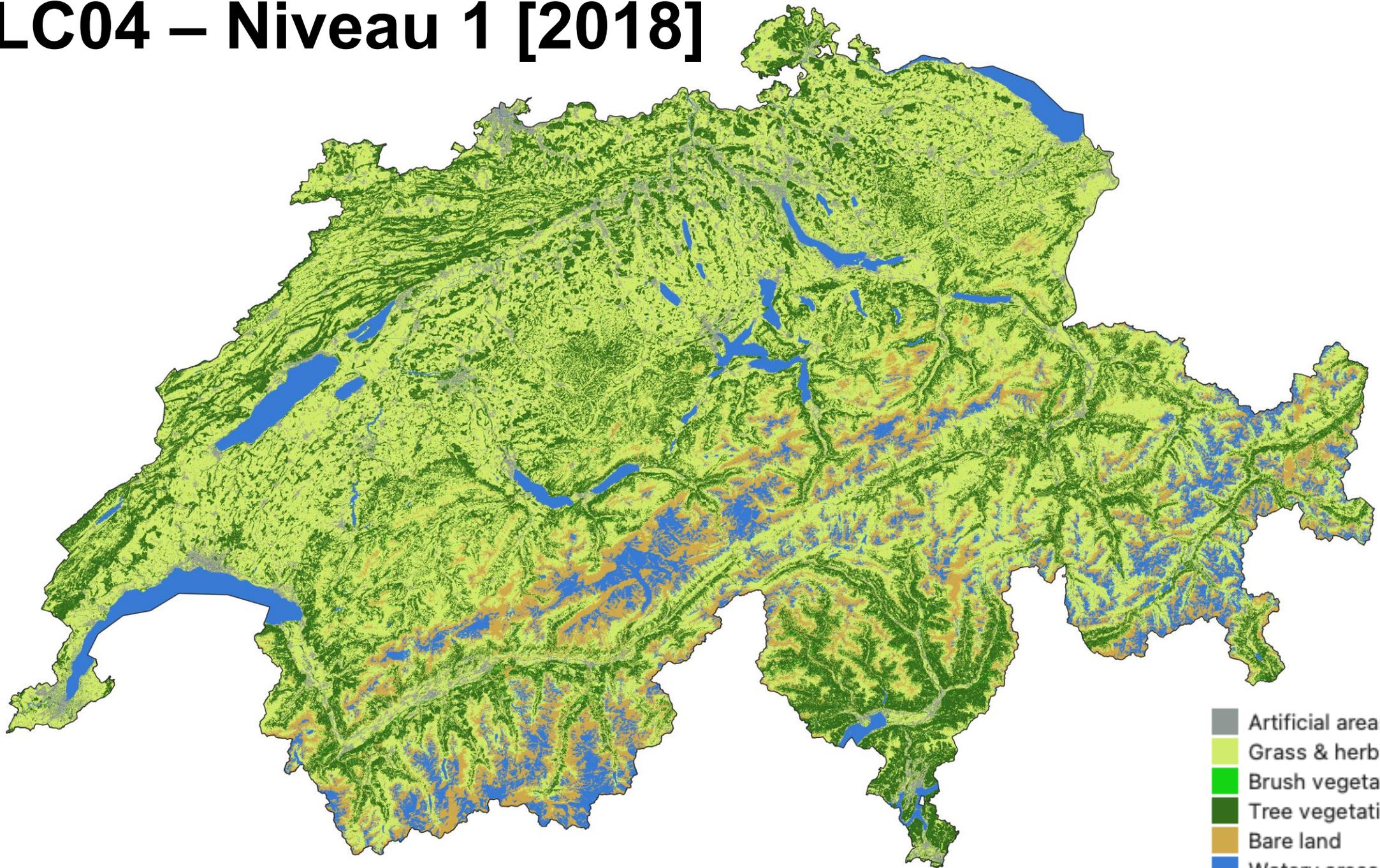


# Traduction de schémas

NOLC04_6	NOLC04_27	LCCS1	LCCS2	LCCS3	L3code	LCCS4	color	#	R	G	B	color
10 – Artificial areas	11 - Consolidated surfaces	Non-veg	Ter	Artificial – B15	215	artisurf_urb_cat = built up; mnolinea_urb_cat = industrial	#909896	144	152	150		
	12 – Buildings	Non-veg	Ter	Artificial – B15	215	artisurf_urb_cat = built up; mardens_urb_cat = high or medium						
	13 - Greenhouses	Non-veg	Ter	Artificial – B15	215	artisurf_urb_cat = built up; urbanveg_urb_cat = urban vegetated						
	14 – Gardens	Veg	Ter	Cultivated – A11	111	artisurf_urb_cat = non built up; lifeform_veg_cat = herbeceous; urbanveg_urb_cat = urban vegetated						
	15 – Lawns	Veg	Ter	Cultivated – A11	111	lifeform_veg_cat = herbeceous; urbanveg_urb_cat = lawns						
	16 – Trees in artificial areas	Veg	Ter	Cultivated – A11	111	lifeform_veg_cat = trees; urbanveg_urb_cat = 6 (urban vegetated)						
	17 – Mix of small structures	Veg	Ter	Cultivated – A11	111	artisurf_urb_cat = non built up; mardens_urb_cat = low or scattered						
20 – Grass & herb vegetation	21 – Grass & herb vegetation	Veg	Ter	Natural – A12	112	lifeform_veg_cat = herbeceous	#d1eb6b	209	235	107		
30 – Brush vegetation	31 - Shrubs	Veg	Ter	Natural – A12	112	lifeform_veg_cat = shrubs	#14d514	20	213	20		
	32 – Brush meadows	Veg	Ter	Natural – A12	112	lifeform_veg_cat = herbeceous; canopyht_veg_con = (0.3 to 0.8 m) ; canopyco_veg_con = open (15 to 40 %)						
	33 – Short-stem fruit trees	Veg	Ter	Cultivated – A11	111	lifeform_veg_cat = woody; leaftype_veg_cat = broad-leaved; phenolog_veg_cat = deciduous; canopyht_veg_con = (0.5 to 2 m)						
	34 – Vines	Veg	Ter	Cultivated – A11	111	lifeform_veg_cat = woody; leaftype_veg_cat = broad-leaved; phenolog_veg_cat = deciduous; canopyht_veg_con = (0.5 to 2 m)						
	35 – Permanent garden plants & brush crops	Veg	Ter	Cultivated – A11	111	lifeform_veg_cat = herbeceous; cropseqt_agr_cat_14a = Simultaneous cropping						
40 – Tree vegetation	41 – Closed forest	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; canopyco_veg_con = closed	#346d1b	52	109	27		
	42 – Forest edges	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; canopyco_veg_con = sparse						
	43 – Forest strips	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; spatdist_veg_cat = striped						
	44 – Open forest	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; canopyco_veg_con = open (which one?)						
	45 – Brush forest	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; canopyht_veg_con = (0.5 to 2 m)						
	46 – Linear woods	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; spatdist_veg_cat = striped						
	47 - Clusters of trees	Veg	Ter	Natural – A12	112	lifeform_veg_cat = woody; spatdist_veg_cat = cellular						
50 – Bare land	51 – Solid rock	Non-veg	Ter	Natural – B16	216	baresurf_phy_cat = consolidated	#d0aa4a	208	170	74		
	52 – Granular soil	Non-veg	Ter	Natural – B16	216	baresurf_phy_cat = unconsolidated						
	53 – Rocky areas	Non-veg	Ter	Natural – B16	216	baresurf_phy_cat = Bare rock a/o coarse fragments						
60 – Watery areas	61- Water	Non-veg	Aqu	Artificial - B27 Natural - B28	227/228	waterstt_wat_cat = water (LCCS3: Waterbodies - B20)	#377bd4	55	123	212		
	62 – Glacier, perpetual snow	Non-veg	Ter	Natural – B28	228	waterstt_wat_cat = snow or ice; snowcper_wat_cin = perennial !!!! (just for snow not ice; but can edit)						
	63 – Wetlands	Veg	Aqu	Natural – A24	124	watersea_veg_cat = Water > 3 months (semi-) permanent						
	64 – Reedy marshes	Veg	Aqu	Natural – A24	124	watersea_veg_cat = Water > 3 months (semi-) permanent; lifeform_veg_cat = herbaceous						

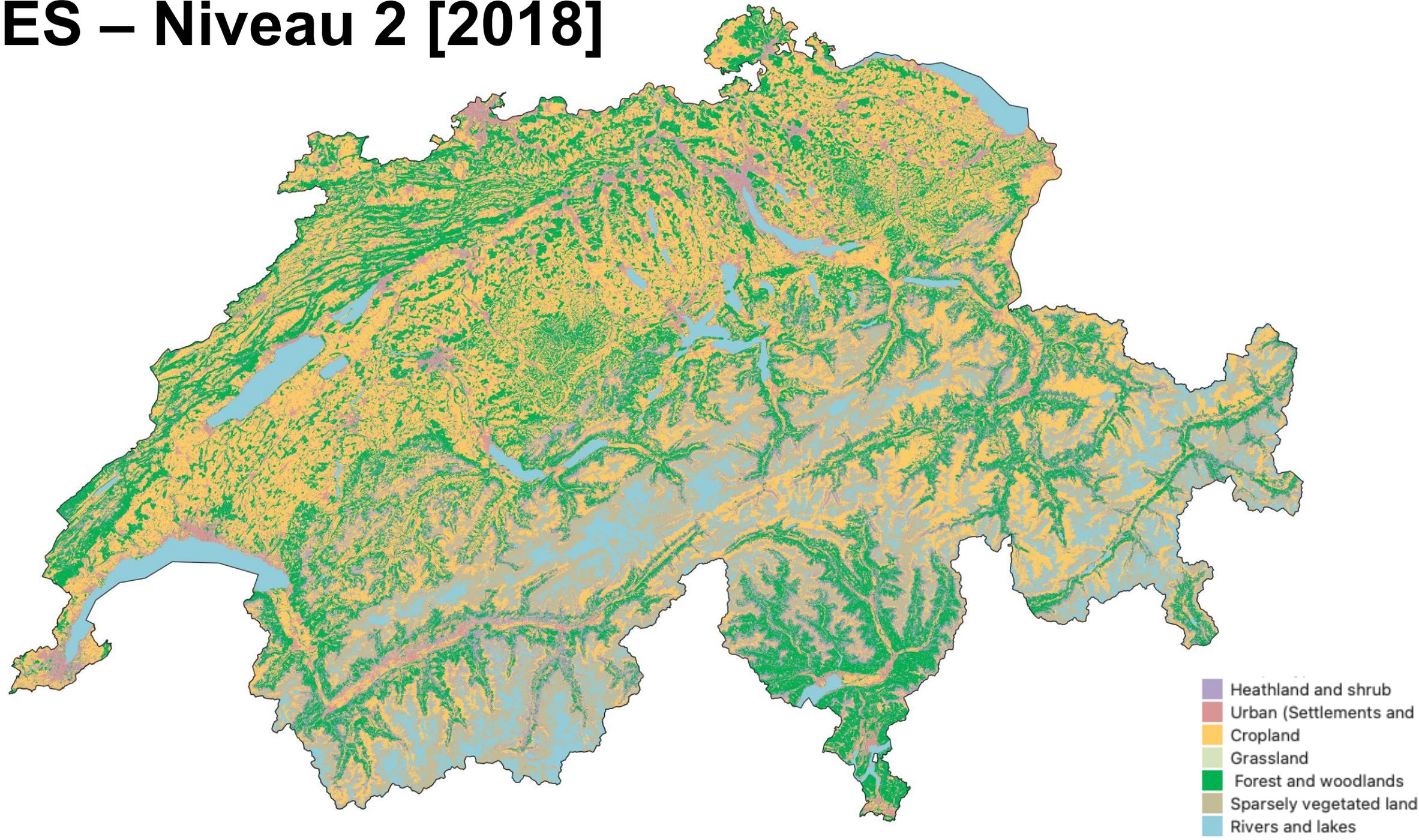
- Couverture du sol: Suisse [NOLC04] - Global [IPCC; ESA CCI] - Europe [CORINE]
- Habitat: Suisse [TypoCH] – Europe [EUNIS]
- Ecosystèmes: Europe [MAES]

# NOLC04 – Niveau 1 [2018]

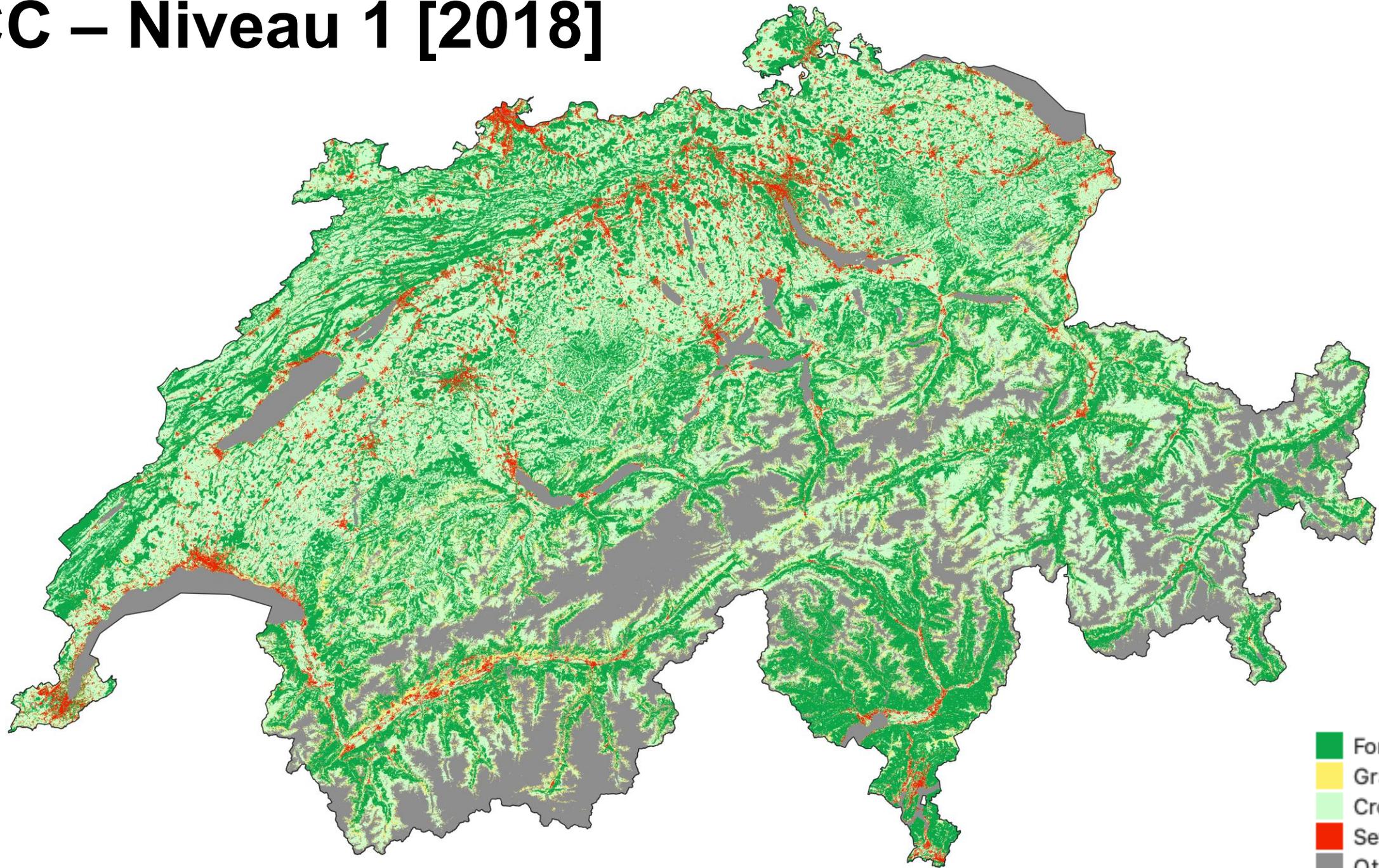


- Artificial areas
- Grass & herb vegetation
- Brush vegetation
- Tree vegetation
- Bare land
- Watery areas

# MAES – Niveau 2 [2018]

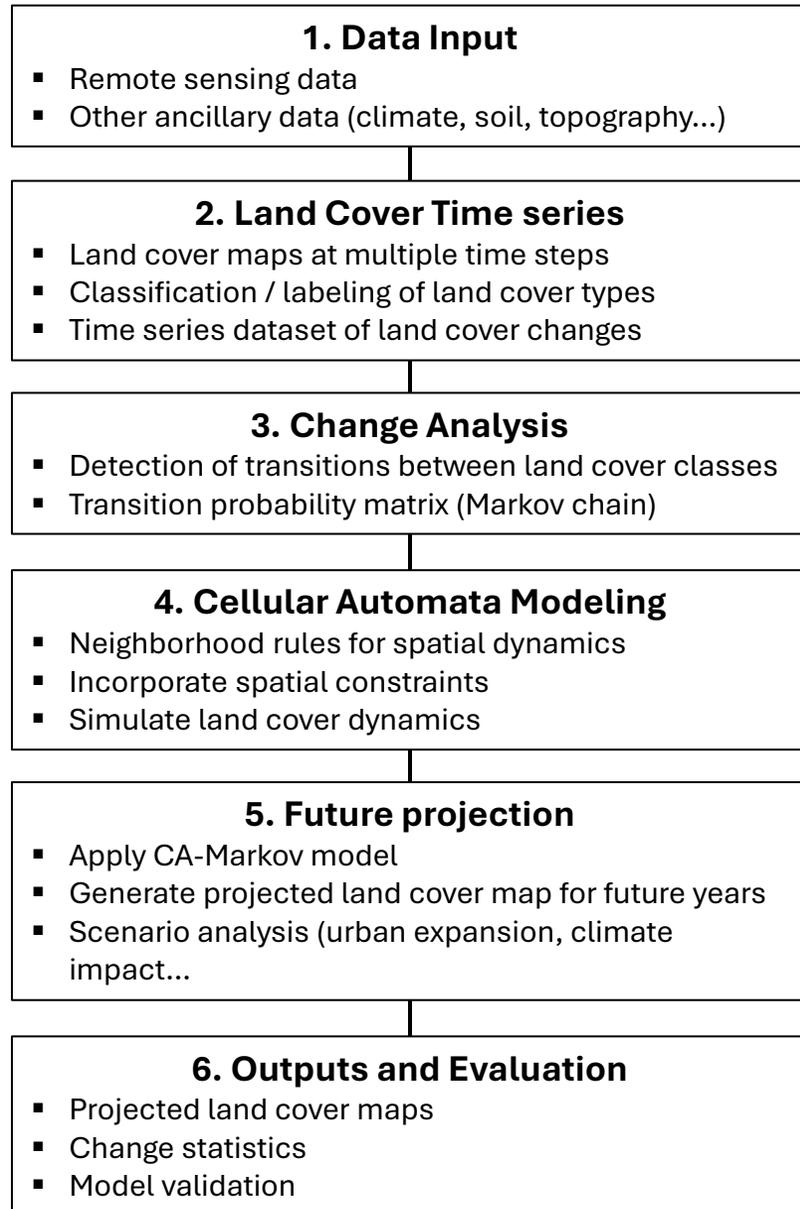


# IPCC – Niveau 1 [2018]

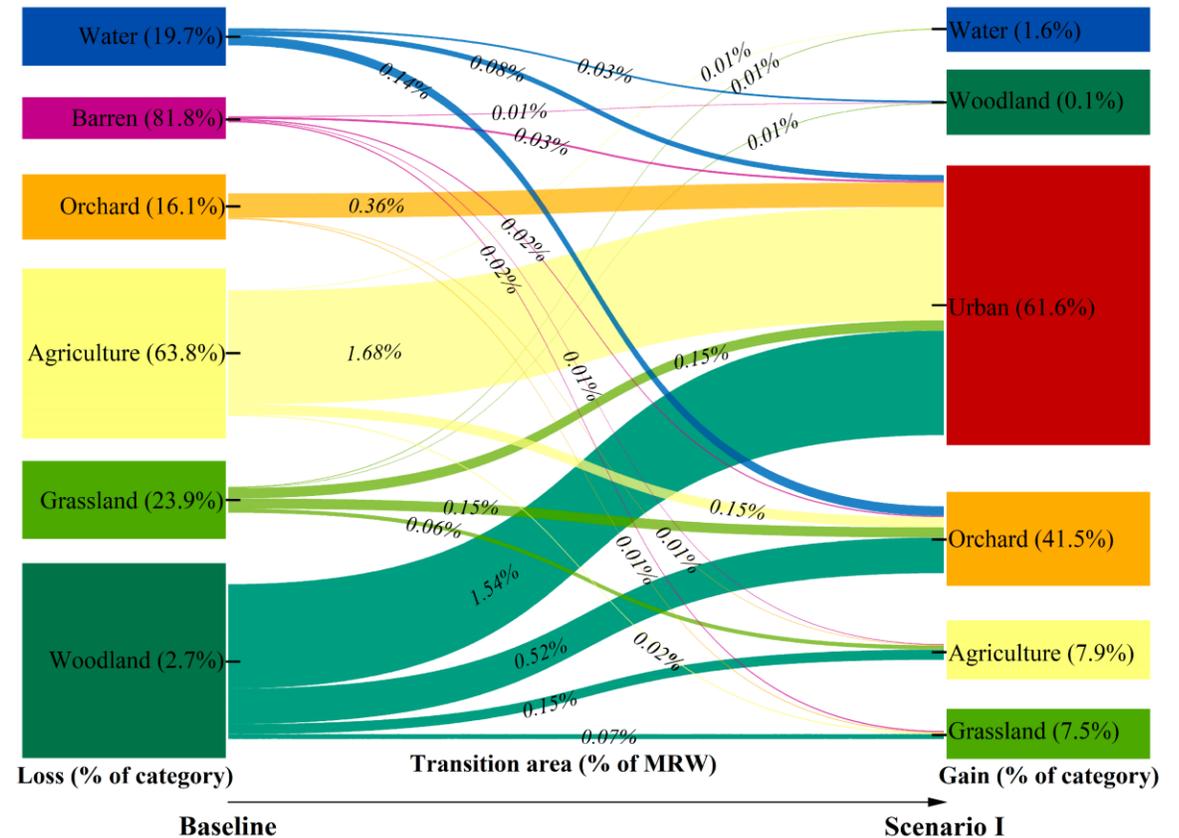


- Forest land
- Grassland
- Cropland
- Settlements
- Other land

# Projections (futur)

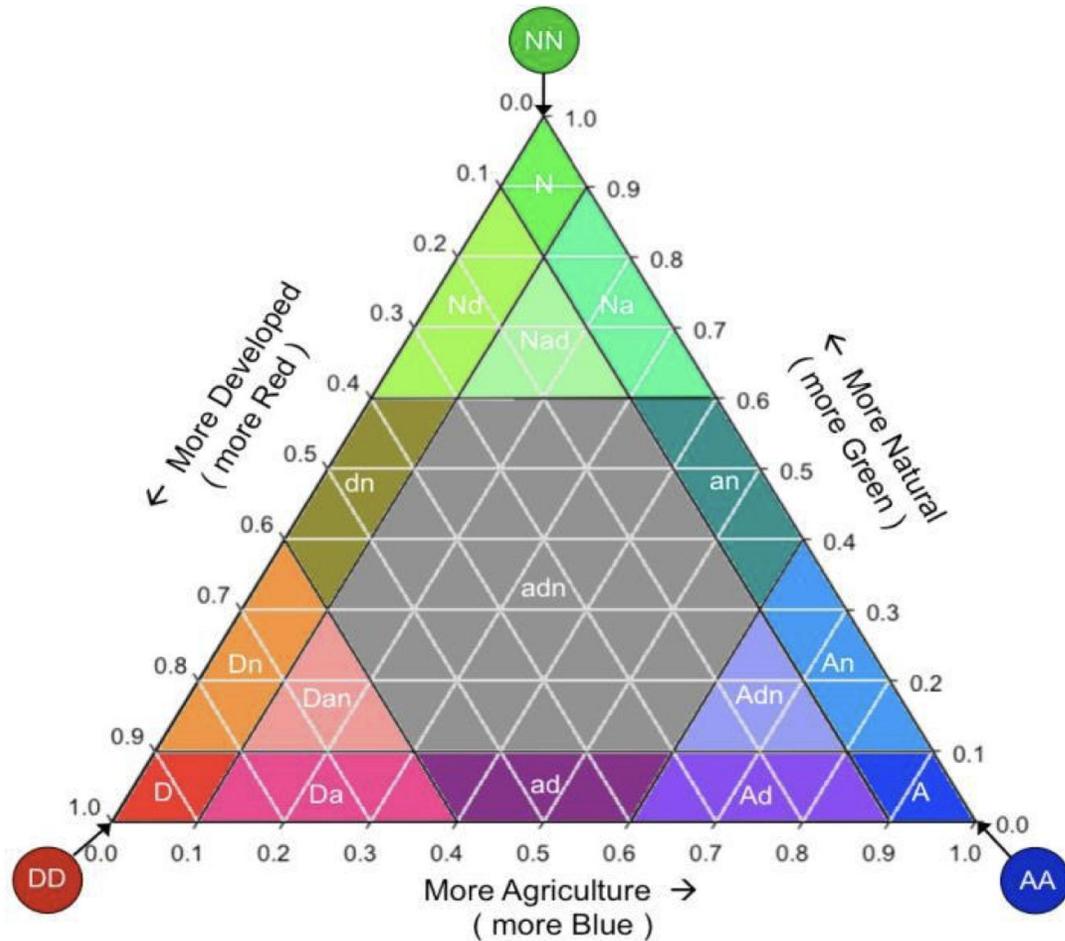


**Patterns of land use change in Southeast China under a Scenario (Zhang et al. 2023).**



# Modèle *Landscape Mosaic*...

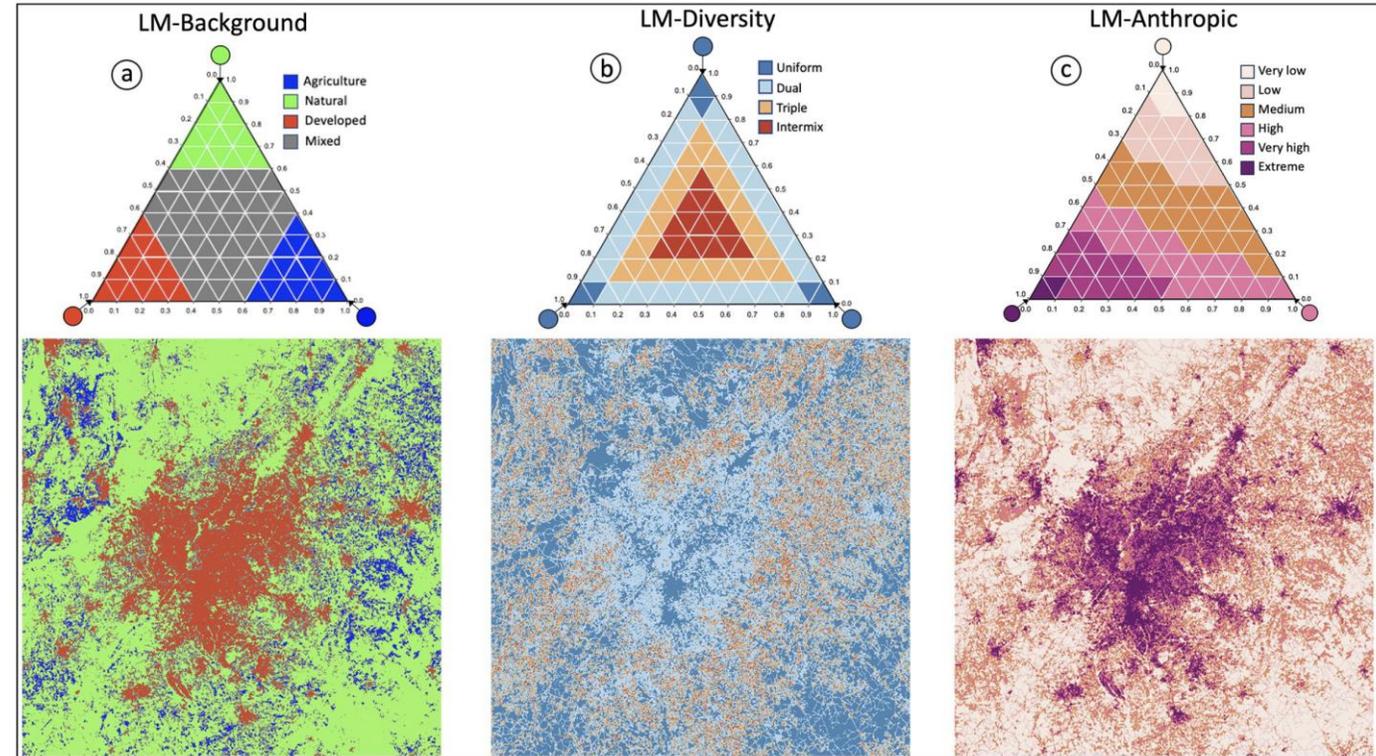
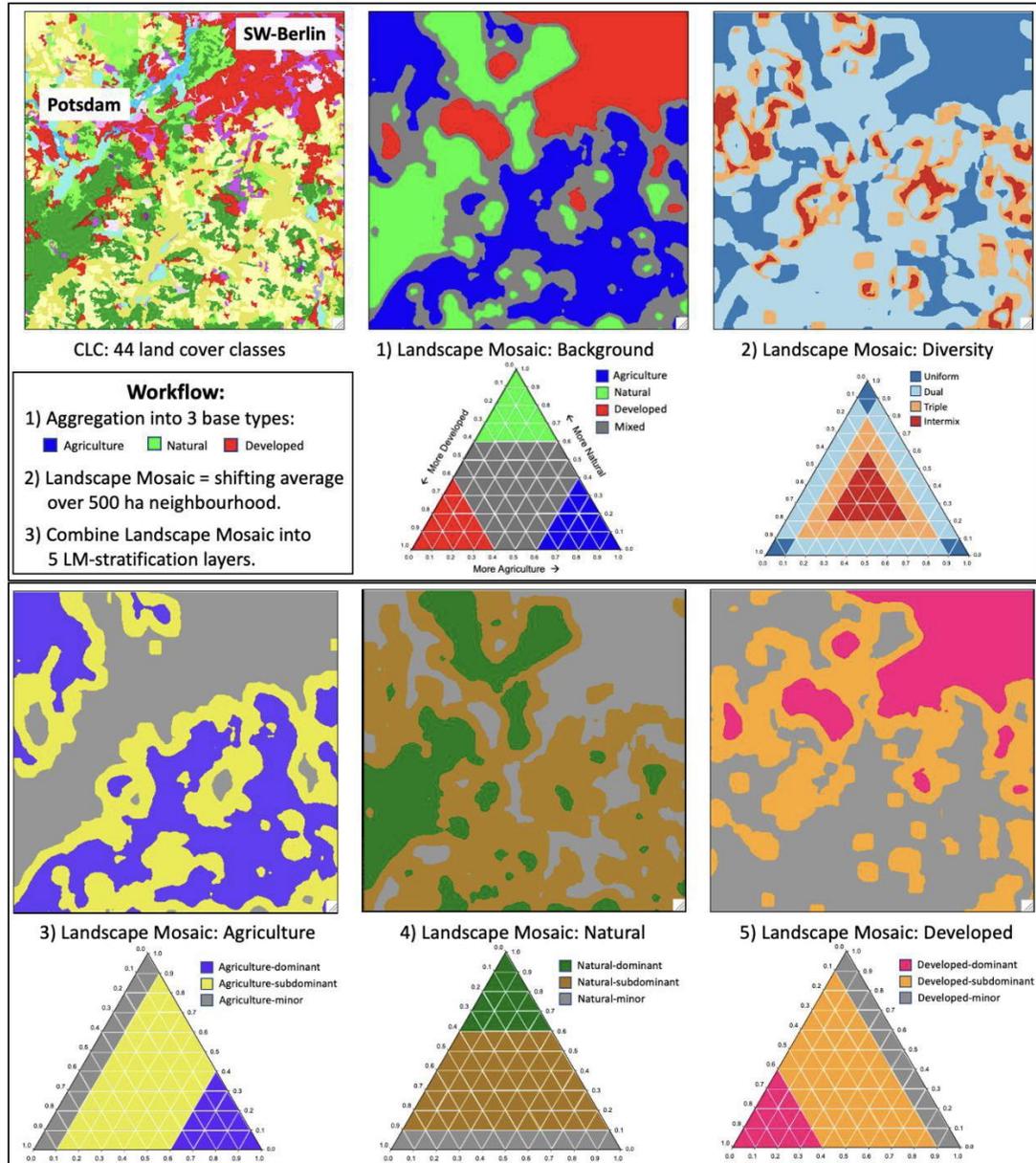
...identifier les impacts anthropiques vs. naturels



Value [byte] - Class Name	Color	RGB
0 - Missing		255/255/255
1 - A		000/000/255
2 - D		255/000/000
3 - N		000/255/000
4 - Ad		128/000/255
5 - An		000/128/255
6 - Dn		255/128/000
7 - Da		255/000/128
8 - Na		000/255/128
9 - Nd		128/255/000
10 - Adn		128/128/255
11 - Dan		255/128/128
12 - Nad		128/255/128
13 - ad		128/000/128
14 - an		000/128/128
15 - dn		128/128/000
16 - adn		128/128/128
17 - NN		000/191/000
18 - AA		000/000/191
19 - DD		191/000/000

Le *Landscape Mosaic* est une classification tripolaire d'un lieu, tenant compte des contributions relatives de trois types de couverture du sol prédominants, **Agriculture**, **Naturel**, **Urbain**, dans la fenêtre spatiale entourant ce lieu. Il fournit une perspective paysagère des **pressions anthropiques** posées par l'agriculture et le développement urbain, et son déplacement spatio-temporel met en évidence les territoires où l'intensité anthropique a changé.

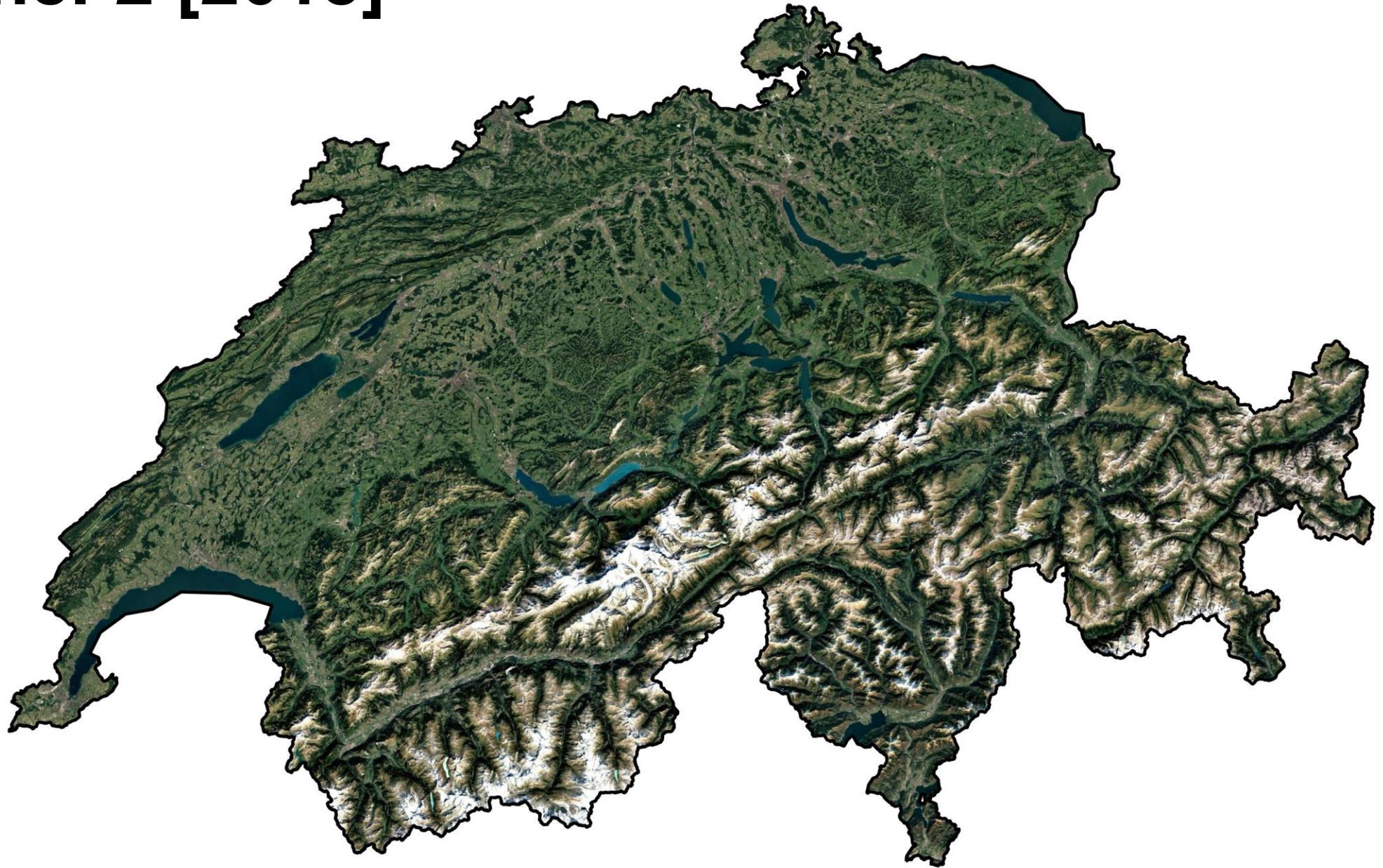
# Modèle *Landscape Mosaic*...



**Fig 3. LM around Atlanta for the year 2021 using a moving window size of 13 pixels. Showing the 103-class LM map and applying different color tables to highlight dominant background land cover (a), degree of diversity (b), or anthropic intensity (c).**

<https://doi.org/10.1371/journal.pone.0304215.g003>

# Sentinel-2 [2018]

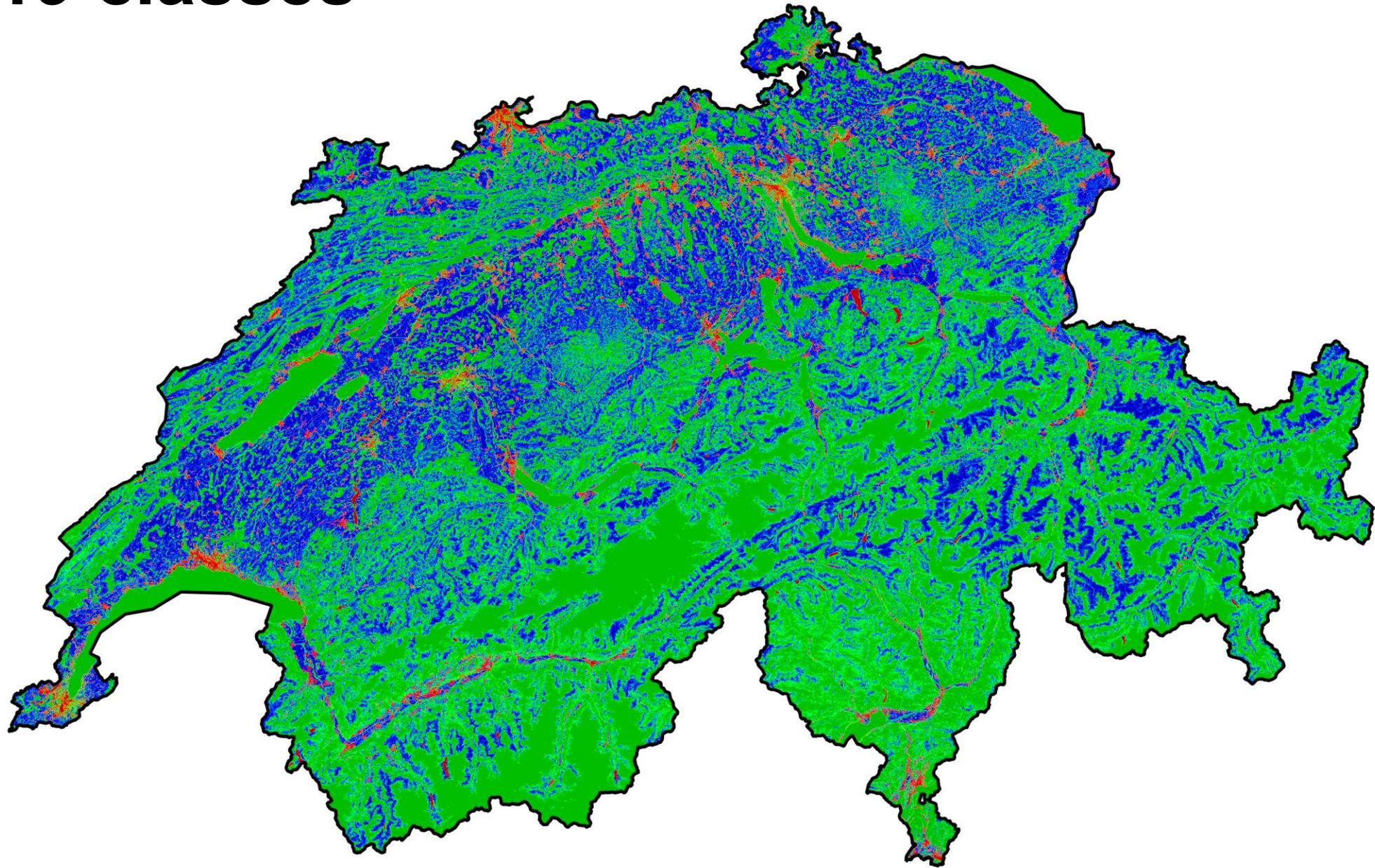


# Couverture du sol [2018]



- Cultivated Terrestrial Vegetated
- Natural Terrestrial Vegetated
- Cultivated Aquatic Vegetated
- Natural Aquatic Vegetated
- Artificial Surface
- Bare Areas
- Artificial Water
- Natural Water

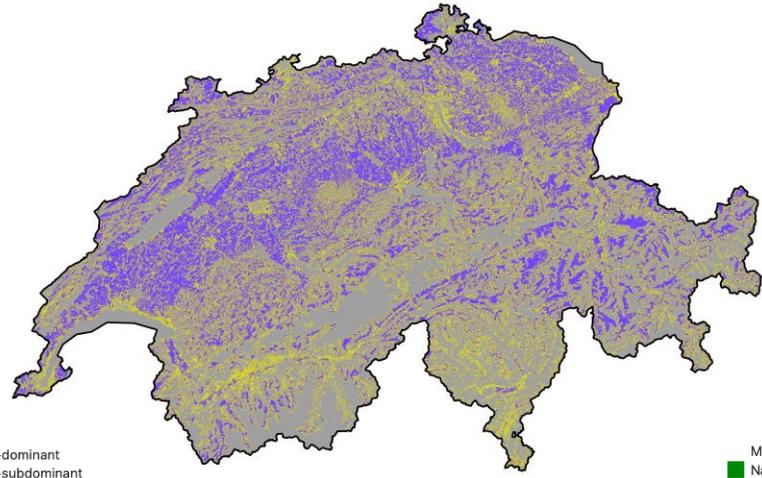
# LM – 19 classes



Missing

- A
- D
- N
- Ad
- An
- Dn
- Da
- Na
- Nd
- Adn
- Dan
- Nad
- ad
- an
- dn
- adn
- NN
- AA
- DD

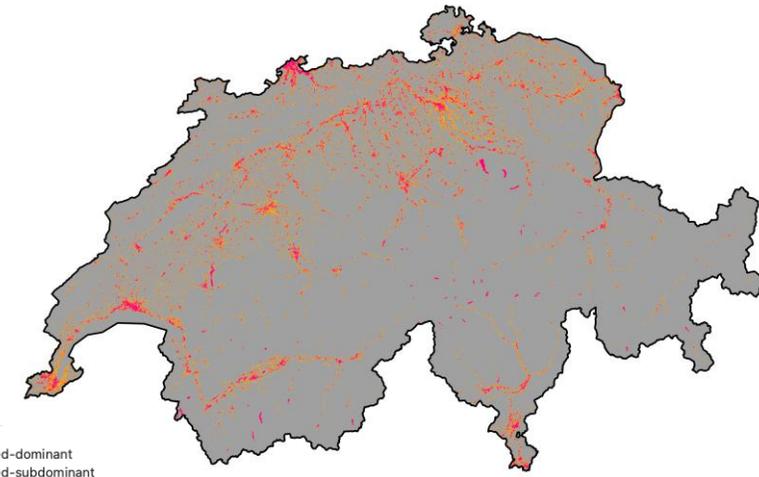
# LM – Produits thématiques [2018]



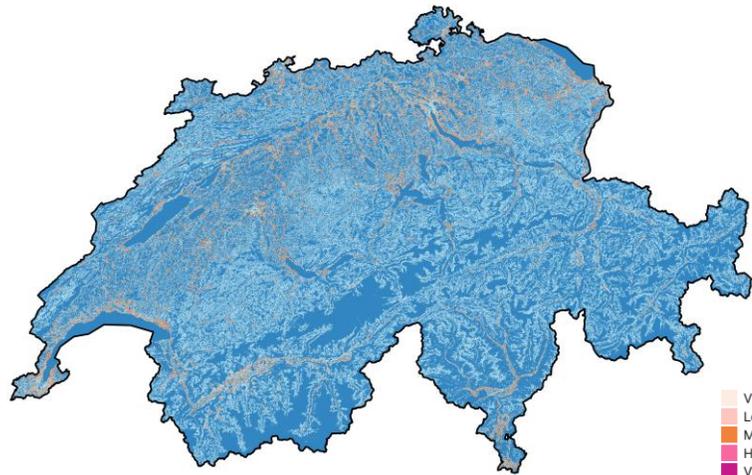
Agriculture



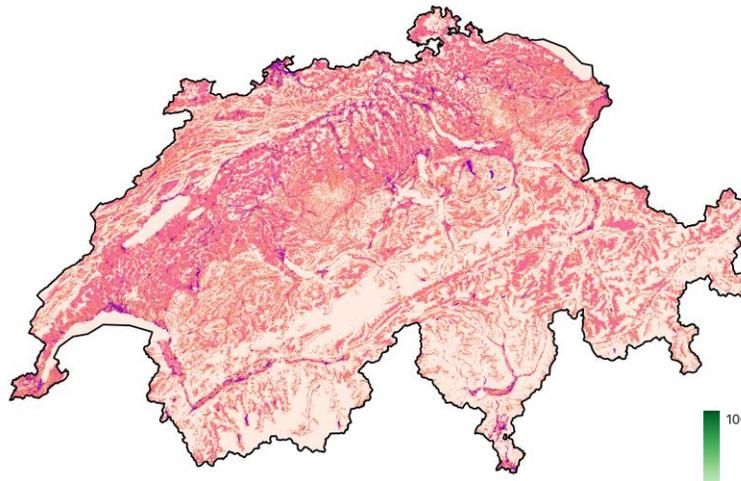
Naturel



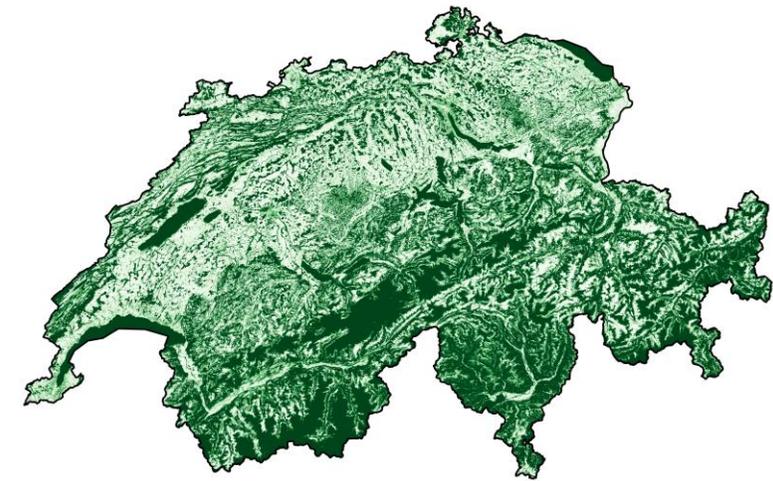
Urbain



Diversité



Intensité Anthropique



Naturalité

Search for locations

Explore data Upload data

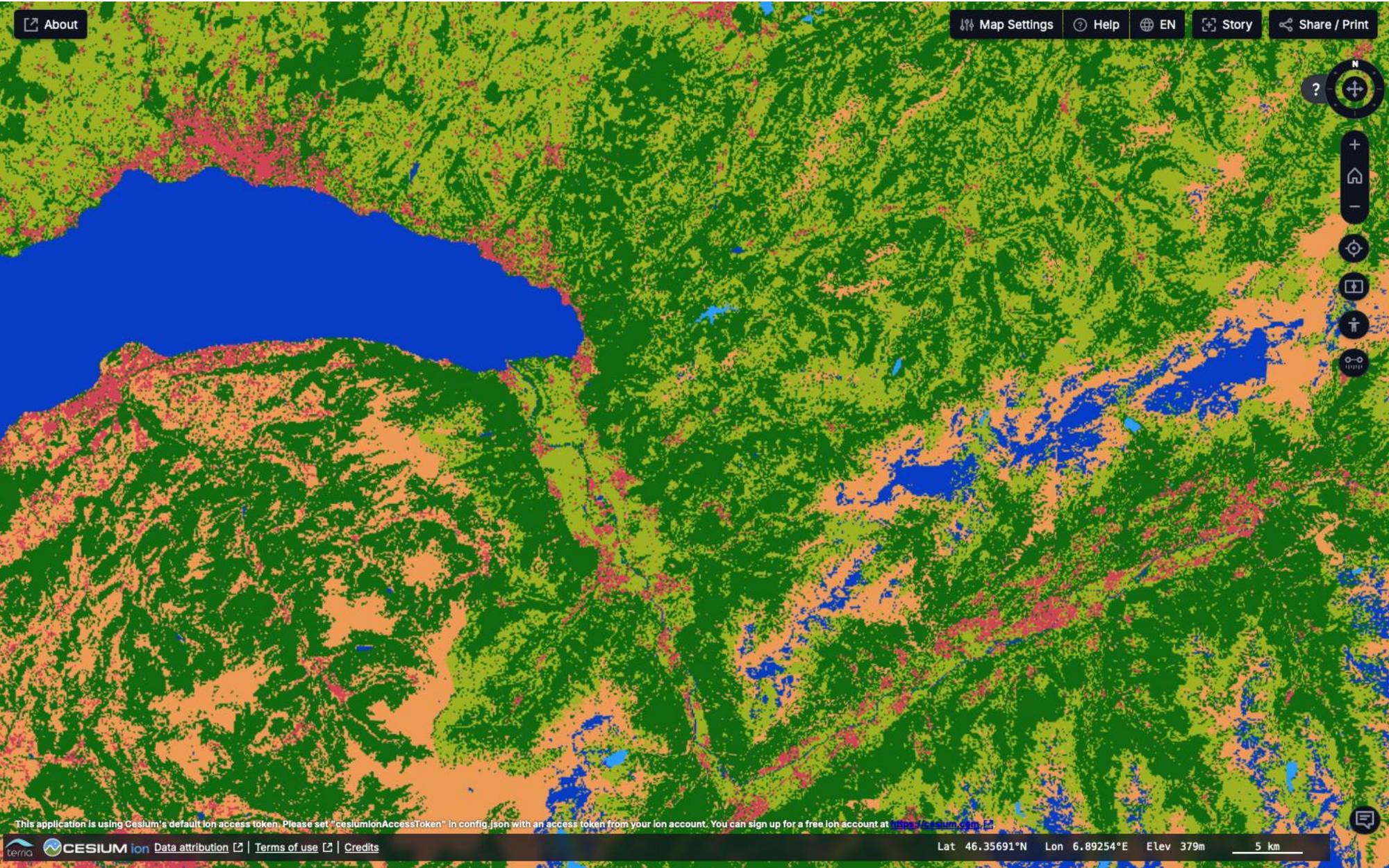
DATASETS (1)

Disable All Collapse All Remove All

level3\_out\_rgb\_ch\_2018

IDEAL ZOOM ABOUT DATA

Opacity: 100 %



Map navigation controls including a north arrow, a search icon, zoom in (+) and zoom out (-) buttons, a home button, a location pin icon, a full-screen icon, and a layer management icon.

Search for locations

Explore data

Upload data

DATASETS (1)

Disable All

Collapse All

Remove All

level3\_out\_rgb\_ch\_2018

IDEAL ZOOM

ABOUT DATA

Opacity: 100 %

About

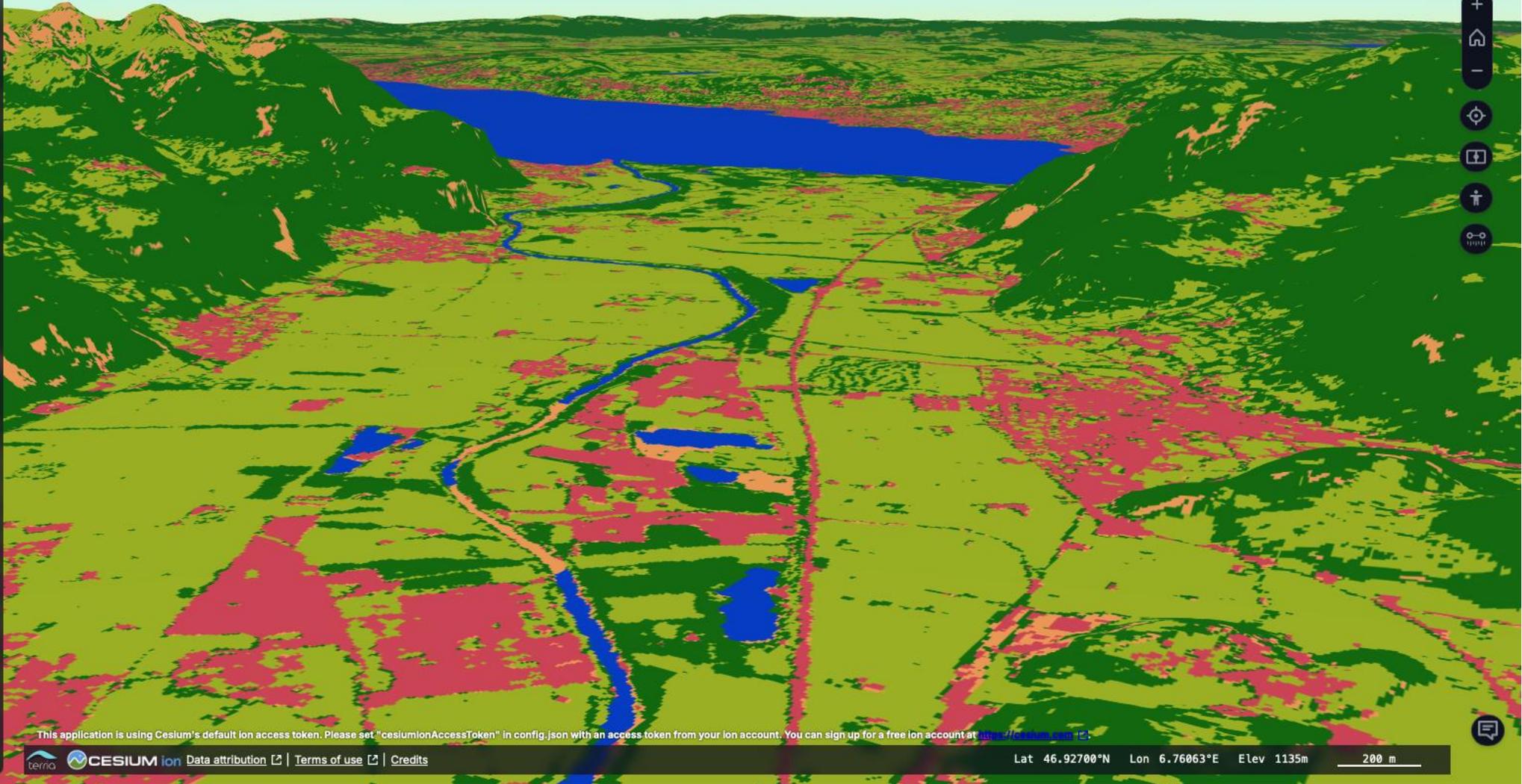
Map Settings

Help

EN

Story

Share / Print



This application is using Cesium's default ion access token. Please set "cesiumionAccessToken" in config.json with an access token from your ion account. You can sign up for a free ion account at <https://cesium.com>.

Search for locations

Explore data Upload data

DATASETS (1)

Disable All Collapse All Remove All

blatten

IDEAL ZOOM ABOUT DATA

Opacity: 100 %



Search for locations

Explore data

Upload data

DATASETS (1)

Disable All

Collapse All

Remove All

blatten

IDEAL ZOOM

ABOUT DATA

Opacity: 100 %

This application is using Cesium's default Ion access token. Please set "cesium:ionAccessToken" in config.json with an access token from your Ion account. You can sign up for a free Ion account at <https://cesium.com/ion/>.

Search for locations

[Explore data](#) [Upload data](#)

DATASETS (3)

[Disable All](#) [Collapse All](#) [Remove All](#)

Opacity: 100 %

[Left](#) [Both](#) [Right](#)

level3\_out\_rgb\_ch\_2018

[IDEAL ZOOM](#) [ABOUT DATA](#)

Opacity: 80 %

[Left](#) [Both](#) [Right](#)

level4\_out\_rgb\_ch\_2018

[IDEAL ZOOM](#) [ABOUT DATA](#)

Opacity: 100 %

This application is using Cesium's default Ion access token. Please set "cesiumIonAccessToken" in config.json with an access token from your Ion account. You can sign up for a free Ion account at <https://cesium.com>

Map navigation controls including a search icon, a compass, zoom in (+) and zoom out (-) buttons, a home button, a location pin button, a full screen button, a close button, a layer visibility button, a search icon, a location pin button, and a layer visibility button.



LCCS ▲

Environmental Descriptors ▼

Vegetation ▼

NDVI annual mean [1984-2018] ⊕

Vegetation Height Model NFI [2018] ⊕

Forest mix rate NFI [2018] ⊕

Copernicus HRL Grassland [2018] ⊕

Copernicus HRL Tree Cover Density [2018] ⊕

Copernicus HRL Dominant Leaf Type [2018] ⊕

Water ▲

Agriculture ▲

Terrain ▲

Snow &amp; Ice ▲

Physical &amp; Bare ▲

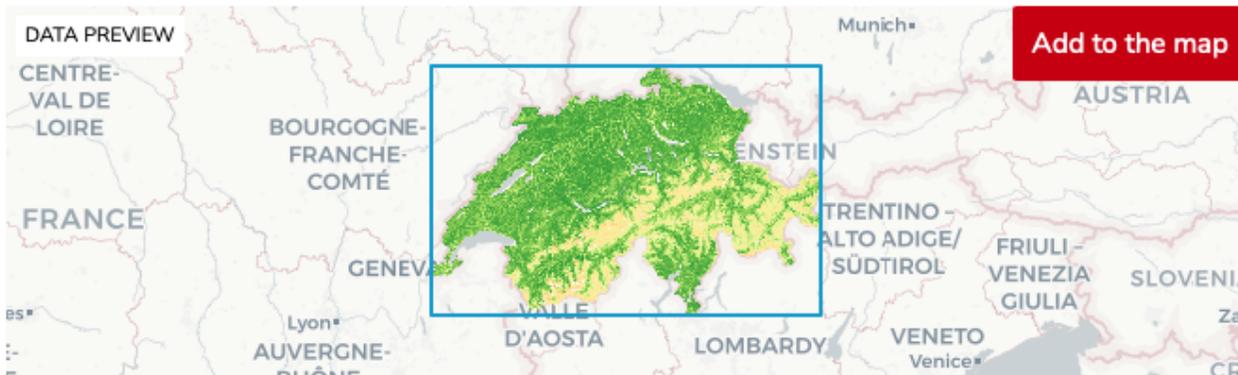
Atmosphere ▲

swisstopo ▲

Sentinel-2 cloudless world 2016 ⊕

Sentinel-2 cloudless world 2018 ⊕

Environmental Descriptors &gt; Vegetation &gt; NDVI annual mean [1984-2018]



## NDVI annual mean [1984-2018]



Please contact the provider of this data for more information, including information about usage rights and constraints.

### ▼ Web Map Service Layer Description

This dataset is a time-series (1984-2018) of NDVI annual mean.

### ▼ Service Description

### ▼ Service Contact

Swiss Data Cube  
[gregory.giuliani@unepgrid.ch](mailto:gregory.giuliani@unepgrid.ch)

### ▼ GetCapabilities URL

<https://geoserver.swissdatacube.org/geoserver/ows?service=WMS&version=1.3.0&request=GetCapabilities>

### ▼ Data Description

# DT4LC - Developing Scalable Digital Twin Models for Land Cover Change Detection Using Machine Learning

Gregory Giuliani, Andrii Shelestov

01.02.2025 – 31.01.2028

## Résumé

## Abstract scientifique

Le projet intitulé DT4LC aborde les défis critiques posés par le changement climatique et les activités humaines sur l'utilisation et la couverture des sols (LUC) en Ukraine et en Suisse. Ces deux pays sont confrontés à des menaces importantes sur le LUC : l'Ukraine, en raison des impacts de la guerre, et la Suisse, à cause du changement climatique. P..

[Afficher plus](#) ▾

## Personnes

### Requérant·es

- [Gregory Giuliani](#), University of Geneva Bd. Carl-Vogt 66, Switzerland
- [Andrii Shelestov](#), National Technical University of Ukraine Kyiv Polytechnic Institute (NTUU KPI)

### Collaboratrices/teurs

- [Alla Lavreniuk](#)
- [Charlotte Poussin](#)
- [Andrii Shelestov](#), National Technical University of Ukraine Kyiv Polytechnic Institute (NTUU KPI), Ukraine

## Aperçu

### Numéro de projet

224912

### Instrument d'encouragement

Ukrainian-Swiss Joint Research Programme (USJRP)

### Mise au concours

Ukrainian-Swiss Joint Research Programme (USJRP) 2023

### Montant accordé

388 900 CHF

### Statut

En cours

### Institution de recherche

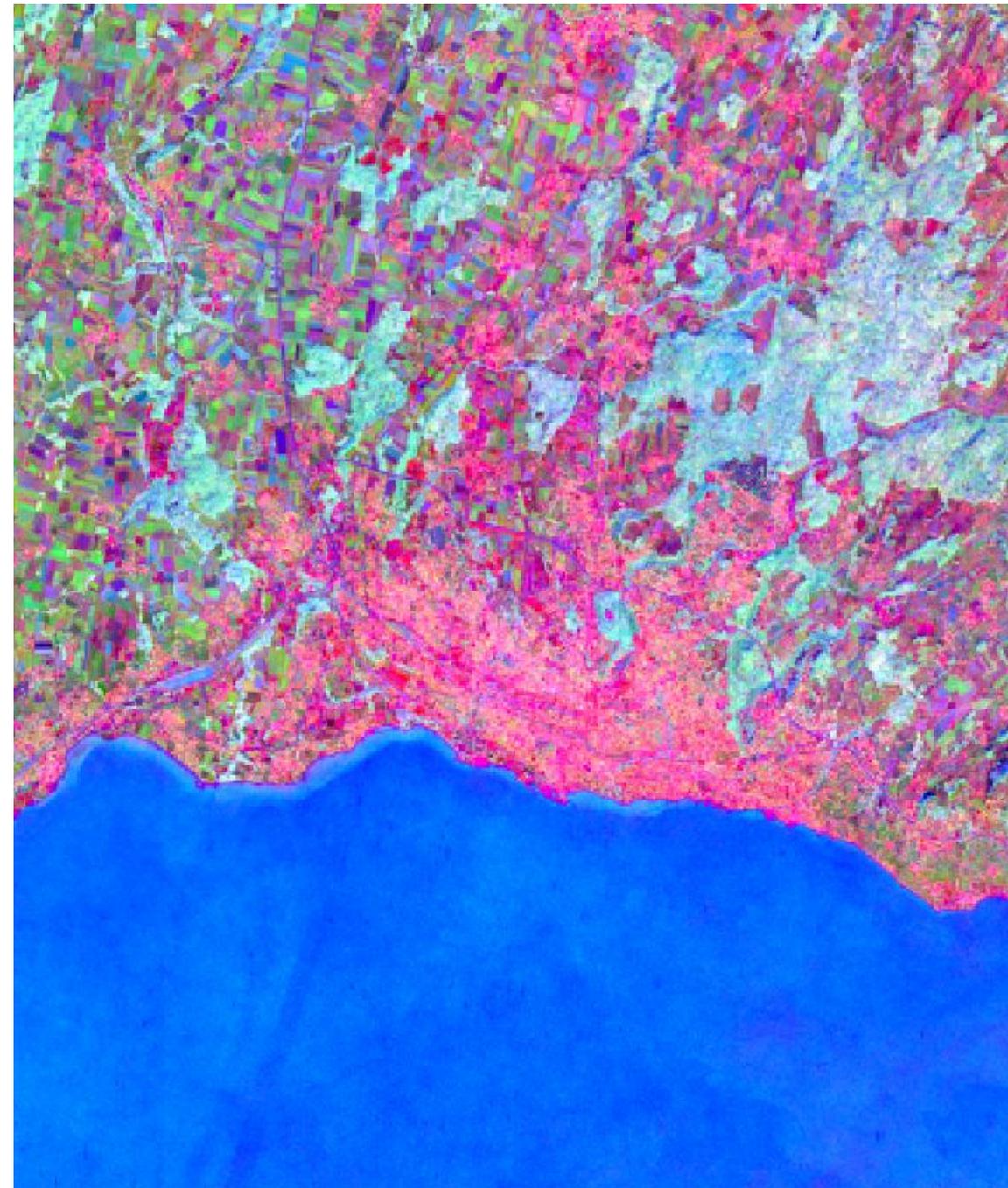
Université de Genève – GE

### Institut

Institut des Sciences de l'Environnement  
Rue de l'Encyclopédie 6 Université de Genève

# Conclusions

- Utilisation des ressources nationales (swisstopo, NFI, OFS, OFEV, SDC, ...)
- Premiers pas vers un système intégré, standardisé et évolutif du suivi de l'environnement
- Sémantiquement consistant
- Open Data, Open Source, Algorithmes, Standards, principes FAIR > science reproductible
- Promotion d'une approche collaborative du développement & possiblement en lien avec les politiques publiques cantonales et fédérales
- Premiers produits disponibles durant la première moitié de 2026





Charlotte  
Poussin



Carole  
Planque



Sébastien  
Chognard



Bruno  
Chatenoux



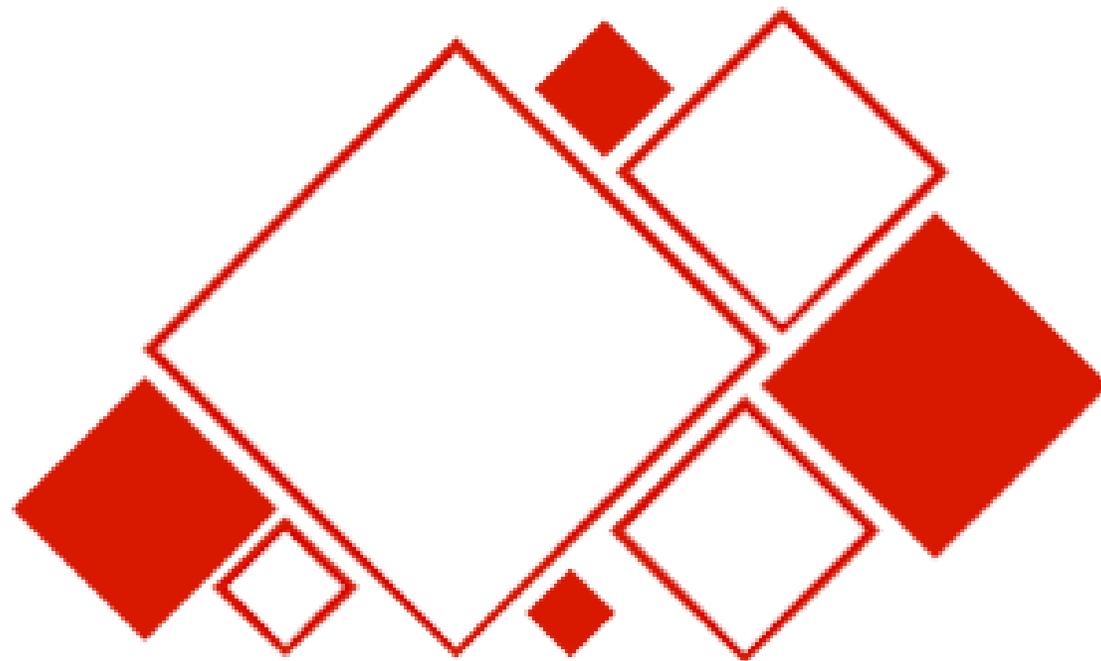
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Lambiel



Pablo  
Timoner



Mona  
Bonnier



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<https://www.unige.ch/envirospace/livingearth>

